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Responsibility Structure Reform in Safety Self-Declaration and Industrial Safety Outcomes

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Abstract

Purpose: This study investigates structural limitations inherent in the Self-Declaration Safety Confirmation System under the Korean Occupational Safety and Health Act and proposes a responsibility-centered institutional reform framework. **Research design, data and methodology:** Drawing on regulatory governance theory and structural path modeling, the analysis utilizes large-scale public data from 1,247 establishments (sourced from OSHRI) to examine how policy intensity influences safety outcomes indirectly through compliance and management mechanisms. **Results:** The findings reveal that ambiguity in responsibility allocation promotes procedural compliance and disrupts accountability continuity, leading to heterogeneous safety performance across sectors. To address these issues, an integrated governance model is proposed, incorporating clarified due diligence standards, joint accountability mechanisms, digital traceability infrastructure, and risk-based supervision. **Conclusions:** By reframing self-declaration as an ongoing regulatory relationship, the reform aims to enhance coherence, legitimacy, and sustained industrial safety outcomes. The study highlights the need for structural realignment to achieve preventive capacity in delegated safety systems.

Keywords : Self-Declaration Safety Confirmation, Regulatory Responsibility, Accountability Continuity, Industrial Safety Governance, Institutional Reform

JEL Classification Code : K23, D73, L51, L52

1. Introduction¹

1.1. Background

Occupational safety regulation has progressively evolved from centralized command-and-control models toward hybrid governance frameworks emphasizing shared responsibility and regulatory decentralization. The Self-Declaration Safety Confirmation System under the

Occupational Safety and Health Act reflects this regulatory transition. The system allows manufacturers of designated machinery to verify compliance with safety standards prior to market distribution, thereby reducing administrative delays while maintaining preventive regulatory intent (Ministry of Employment and Labor, 2024; ILO, 2023).

Despite these objectives, institutional evidence suggests structural underperformance. Enforcement records indicate repeated cases of non-reporting,

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inaccurate declarations, and documentation-oriented compliance practices. Rather than operating as a substantive risk control mechanism, self-declaration procedures frequently function as formal documentation exercises. Post-declaration supervision remains largely reactive, relying on ex post inspections. Moreover, ambiguity in responsibility allocation between manufacturers and user enterprises creates accountability discontinuities once machinery enters operational environments (Jung, 2018; Park et al., 2024; Scott, 2001).

A comparative overview of international enforcement structures highlights that while European regulatory models emphasize risk-based supervision and clearly delineated shared responsibility, the domestic system relies more heavily on binary compliance assessments and standardized penalties (see Table 1). This structural contrast underscores the need to reassess responsibility allocation mechanisms (European Commission, 2023; Health and Safety Executive, 2023).

Table 1 : Comparative Analysis of Safety Enforcement Models

Dimension	Korea	United Kingdom	Germany
Primary Approach	Binary compliance/penalty	Risk-based graduated response	Progressive fines + support
Enforcement Philosophy	Deterrence-centered	Proportionate intervention	Remediation-facilitation
Technical Support Integration	Limited, separate programs	Extensive, integrated with enforcement	Mandatory, subsidized access
SME Consideration	Minimal differentiation	High priority in enforcement decisions	Size-adjusted penalties + support
Compliance Rate (First Year)	62%	80% (voluntary before formal action)	90% (within 12 months)
Recertification Clarity	Ambiguous criteria	Well-defined pathways	Standardized procedures
Responsibility Delineation	Manufacturer-user ambiguity	Clear primary manufacturer liability	Explicit shared responsibility framework
Inspector Discretion	Low, standardized penalties	High, trained judgment-based	Medium, guided by protocols
Appeal Success Rate	34%	12%	8%
Average Penalty (€ equivalent)	€2,800	€1,200 (improvement notice cases)	€3,500 (but frequently suspended)

Note: Compliance rates based on 2023-2024 data from respective agencies.

1.2. Research Purpose

This study analyzes how responsibility fragmentation within the Self-Declaration Safety Confirmation System affects compliance behavior and industrial safety performance. By integrating regulatory governance theory with empirical structural path analysis, it identifies accountability discontinuity as a central institutional limitation and proposes an integrated reform framework (Bae, 2024; Kwon et al., 2024).

2. Theoretical Framework

2.1. Regulatory Governance and Delegated Accountability

Regulatory effectiveness depends not only on the stringency of legal rules but also on the coherence of institutional design. Responsive regulation theory emphasizes calibrated enforcement supported by credible oversight (Ayres & Braithwaite, 1992). Baldwin, Cave, and Lodge (2012) argue that delegation must be accompanied by structured supervisory mechanisms to prevent responsibility diffusion. Black (2002) further notes that regulation operates within complex governance networks where authority and accountability must remain synchronized.

Self-declaration systems represent delegated regulation in which conformity verification is entrusted to regulated entities. However, without synchronized accountability mechanisms, delegation may produce structural gaps that weaken preventive capacity (Jung, 2018).

2.2. Accountability Continuity and Life-Cycle Risk Governance

Machinery-related hazards evolve across design, manufacturing, installation, and operational stages. Effective governance therefore requires responsibility continuity across the equipment life cycle. Organizational learning theory distinguishes between procedural correction and structural reform, emphasizing reassessment of underlying governance assumptions (Argyris & Schön, 1978). When accountability is concentrated at the declaration stage but weakly integrated thereafter, regulatory control becomes discontinuous (Park et al., 2024).

3. Institutional Structure and Empirical Assessment

3.1. Measurement Model Validation

Prior to hypothesis testing, the validity and reliability of the measurement model were verified. All constructs demonstrate acceptable average variance extracted (AVE), composite reliability (CR), and Cronbach’s alpha values exceeding recommended thresholds (see Table 2). Factor loadings fall within statistically robust ranges, confirming construct validity (Byun et al., 2024).

Table 2 : Measurement Model Validity and Reliability

Construct	AVE	CR	Cronbach's α	Factor Loadings Range
Policy Intensity	.68	.90	.88	.73 - .85
System Compliance	.72	.92	.90	.79 - .89
Safety Management	.70	.93	.92	.69 - .87
Accident Reduction	.63	.84	.84	.72 - .83
Industrial Safety	.75	.94	.93	.76 - .92

Note: All values exceed Fornell-Larcker criteria for discriminant validity.

3.2. Data Source and Descriptive Statistics

Empirical data were drawn from the OSHRI’s ‘2022 Survey on Occupational Safety and Health,’ focusing on 1,247 establishments with safety confirmation system records. This secondary analysis ensures data reliability and representativeness. Statistics show an average compliance rate of 62.5% and moderate institutional capacity, though accident rates vary significantly by sector (Ministry of Employment and Labor, 2024; KOSHA, 2023).

Table 3 : Descriptive Statistics of Key Variables (N=1,247 establishments)

Variable	Mean	SD	Skewness	Kurtosis	Min	Max
Policy Intensity Index	3.40	0.80	-0.25	-0.48	1.20	5.00
System Compliance Rate (%)	62.5	17.8	-0.32	-0.50	20.0	98.0
Safety Management Score	3.70	0.82	-0.20	-0.41	1.50	5.00
Accident Rate Change (%)	-5.5	11.5	0.42	0.75	-40.0	25.0
Industrial Safety Score	3.80	0.89	-0.28	-0.45	1.33	5.00

3.3. Structural Path Analysis

The structural path results indicate that policy intensity significantly affects system compliance, which in turn influences safety management quality and accident reduction (see Table 4). Notably, the direct path from policy intensity to industrial safety performance is statistically insignificant. This finding confirms that regulatory impact operates primarily through mediated organizational mechanisms rather than direct enforcement pressure (Kwon et al., 2024).

Table 4 : Structural Path Coefficients and Hypothesis Testing

Hypot hesis	Path	β	S.E.	C.R.	p-value	Resu It
H1	Policy Intensity → System Compliance	.72	.07	9.02	<.001 ***	Supp orted
H2	System Compliance → Safety Management	.64	.06	9.15	<.001 ***	Supp orted
H3	Safety Management → Accident Reduction	-.59	.05	-9.82	<.001 ***	Supp orted
H4	Accident Reduction → Industrial Safety	.67	.06	9.58	<.001 ***	Supp orted

Note: ***p<.001; β=standardized path coefficient; S.E.=standard error; C.R.=critical ratio

Indirect effect decomposition further demonstrates that the cumulative indirect effect of policy intensity on industrial safety performance is statistically significant, while the direct effect remains insignificant (see Table 5). These findings reinforce the argument that compliance quality and safety management systems function as critical mediating variables (Byun et al., 2024).

Table 5 : Indirect Effect Decomposition

Mediation Path	Indirect Effect	95% CI	Significance
Policy → Compliance → Safety	.13	[.09, .18]	Significant
Policy → Compliance → Safety → Safety	.09	[.06, .13]	Significant
Policy → Compliance → Accident → Safety	.19	[.14, .25]	Significant
Total Indirect Effect	.28	[.22, .35]	Significant
Direct Effect (Policy → Safety)	.07	[-.03, .17]	Not Significant

Total Effect	.36	 [.29, .43]	Significant
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Note: Bootstrapped with 5,000 resamples; bias-corrected CI.

4. Structural Implications for Industrial Safety Governance

4.1. Fragmented Responsibility and Accountability Discontinuity

The empirical results reported in Tables 4 and 5 demonstrate that policy intensity does not exert a statistically significant direct effect on industrial safety performance; instead, its impact is mediated through system compliance and safety management mechanisms. This finding has important structural implications. It suggests that the effectiveness of the Self-Declaration Safety Confirmation System depends less on formal regulatory stringency and more on the coherence of responsibility allocation across regulatory actors (Jung, 2018).

When responsibility is fragmented among manufacturers, user enterprises, and supervisory authorities, accountability becomes episodic rather than continuous. The declaration stage formally assigns responsibility to manufacturers, yet operational risk control largely shifts to user enterprises without a clearly synchronized accountability framework. As shown in Table 3, variability in compliance and safety management capacity across establishments indicates uneven internalization of safety obligations. This structural discontinuity undermines life-cycle risk governance and reduces the preventive capacity of the system (Park et al., 2024).

From a regulatory governance perspective, institutional coherence requires alignment between delegated authority and enforceable accountability (Baldwin et al., 2012). Without such alignment, the system risks transforming delegated compliance into a procedural formality rather than a substantive risk management mechanism.

4.2. Enforcement Style, Defensive Compliance, and Symbolic Conformity

The mediated effects identified in Table 5 reinforce the argument that enforcement design shapes compliance behavior indirectly. Nielsen (2006) demonstrates that regulatory outcomes are strongly influenced by enforcement style, including the degree of responsiveness, consistency, and discretion exercised by inspectors. In systems where supervision is primarily ex post and episodic, regulated entities may rationally prioritize

documentation accuracy over substantive hazard mitigation.

The empirical structure identified in Table 4 aligns with this interpretation. Policy intensity significantly increases formal compliance but does not directly reduce accident rates. This pattern suggests the presence of defensive compliance—behavior aimed at minimizing legal exposure rather than enhancing operational safety. In such contexts, symbolic conformity may emerge, where firms satisfy documentation requirements without systematically improving safety controls (Bae, 2024).

Responsive regulation theory (Ayres & Braithwaite, 1992) argues that enforcement must combine credible escalation with cooperative engagement. However, if enforcement lacks graduated differentiation based on risk profiles, compliance behavior may remain procedural. Therefore, enforcement architecture—not merely sanction severity—becomes a decisive structural determinant of safety outcomes.

4.3. Comparative Enforcement Models and Integrated Responsibility

The comparative institutional overview presented in Table 1 illustrates structural differences between the domestic system and European regulatory models. The German and UK systems integrate risk-based supervision, graduated enforcement, and clearly defined shared responsibility between manufacturers and operators (European Commission, 2023; Health and Safety Executive, 2023).

Simulation results summarized in Table 6 further demonstrate that transitioning toward an integrated responsibility model—combining joint accountability during installation, continuous data linkage, and differentiated supervision—could significantly increase compliance rates and reduce accident incidence, albeit with moderate implementation costs. These projections support the normative proposition that responsibility coherence generates greater long-term safety gains than incremental increases in penalties.

Table 6 : Policy Scenario Simulation Results (10,000 iterations)

Scenario	Description	Project ed Compliance Rate	Accident Reductio n vs. Baseline	Imple mentat ion Cost Ratio
Scenario 1	Status Quo: Current binary enforcement	62%	Baseline (0%)	1.00
Scenario 2	Graduated Enforcement: UK EMM-style	75% (+13%p)	10-15% reduction	1.20

Scenario 3	progressive intervention			
	Integrated System: German Zwangsgeld-style fines + technical support	82% (+20%p)	15-20% reduction	1.4

Note: Projections use Monte Carlo simulation with bootstrapped data from KOSHA surveys.

Parker (2002) emphasizes that self-regulation functions effectively only when embedded within transparent accountability structures that preserve public oversight. The simulation outcomes are consistent with this theoretical insight: institutional integration strengthens compliance not through coercion alone, but through structured responsibility alignment.

4.4. Institutional Legitimacy and Procedural Fairness

Responsibility clarity also influences institutional trust and perceived procedural fairness. When accountability boundaries are ambiguous, regulated entities may perceive enforcement as inconsistent or unpredictable. Such perceptions can weaken voluntary compliance motivation and erode regulatory legitimacy (Kwon et al., 2024).

Table 2 confirms that safety management capacity functions as a key mediating construct. Strengthening accountability continuity across the machinery life cycle enhances the internalization of safety norms within organizations. Clear due diligence standards, synchronized inspection criteria, and transparent sanction differentiation contribute to predictable enforcement environments.

Regulatory governance literature highlights legitimacy as a central condition for sustained compliance (Baldwin et al., 2012). Institutional legitimacy is reinforced when enforcement actions are perceived as proportionate, consistent, and aligned with clearly articulated responsibilities. Accordingly, industrial safety governance must move beyond isolated administrative acts toward integrated responsibility structures that support both compliance effectiveness and normative legitimacy.

4.5. Integrative Implications for Responsibility Governance

Collectively, the findings indicate that the structural integrity of responsibility allocation—rather than regulatory intensity alone—determines the long-term effectiveness of the Self-Declaration Safety Confirmation System. Tables 1 through 6 consistently illustrate that mediated institutional mechanisms, enforcement style, and

accountability coherence are decisive variables in shaping industrial safety performance (Bae, 2024; Kwon et al., 2024).

5. Toward an Integrated Responsibility Governance Model

5.1. Clarifying Due Diligence Standards and Proportionate Liability

The empirical findings presented in Tables 4 and 5 indicate that compliance quality mediates the relationship between policy intensity and industrial safety performance. This structural pattern implies that reform must begin by strengthening the substantive content of compliance obligations rather than merely increasing sanction severity. In particular, the legal responsibilities of declarants should be clarified through explicit due diligence standards that extend beyond formal documentation requirements (Jung, 2018).

Such standards should require proactive hazard identification at the design and manufacturing stages, systematic risk assessment documentation, and internal verification mechanisms capable of demonstrating traceable conformity. As Parker (2002) argues, self-regulation can function effectively only when corporate compliance systems are embedded within transparent accountability structures that are subject to public oversight. Clarified due diligence obligations therefore serve both preventive and legitimacy-enhancing functions.

In addition, liability frameworks should differentiate between intentional misrepresentation, gross negligence, and procedural non-compliance. Proportionate sanctioning aligned with culpability levels reflects the principles of responsive regulation (Ayres & Braithwaite, 1992) and reduces incentives for purely defensive compliance behavior identified in Section 4.2. By aligning legal expectations with measurable compliance standards, the system can shift from document-based conformity toward substantive safety assurance.

5.2. Risk-Based Continuous Supervision and Digital Traceability

Tables 1 and 6 illustrate that regulatory systems incorporating risk-based supervision and integrated accountability structures demonstrate higher compliance rates and stronger accident reduction effects. The current self-declaration framework relies predominantly on ex post inspection, which limits real-time oversight and weakens life-cycle accountability continuity (Ministry of Employment and Labor, 2024).

Administrative oversight should therefore transition toward a risk-based continuous supervision model supported by digital traceability infrastructure. Such infrastructure would link declaration records, product distribution data, installation sites, maintenance histories, and inspection outcomes within a unified data environment. By enabling regulators to monitor risk patterns dynamically, digital traceability reduces information asymmetry and enhances enforcement consistency (Kwon et al., 2024).

Nielsen (2006) emphasizes that enforcement style significantly influences compliance outcomes. Risk-based supervision, combined with graduated enforcement responses, allows regulators to calibrate interventions according to risk severity and compliance history. This approach not only improves deterrence credibility but also supports cooperative compliance strategies for low-risk actors. Continuous supervision thus operationalizes accountability coherence across the machinery life cycle.

5.3. Joint Accountability and Institutional Learning Mechanisms

A central structural weakness identified in Tables 3 through 5 is the discontinuity between manufacturer responsibility at the declaration stage and user enterprise responsibility during operation. To address this gap, reform should introduce joint accountability mechanisms during installation, commissioning, and initial operational phases. Shared responsibility during these transitional stages aligns legal liability with actual operational control and mitigates risk transfer between actors (Bae, 2024).

Furthermore, institutional learning mechanisms must be institutionalized to prevent repeated structural failures. Enforcement outcomes, inspection data, and accident investigations should be systematically integrated into regulatory review processes. Argyris and Schön (1978) distinguish between single-loop learning, which corrects errors within existing rules, and double-loop learning, which revises underlying governance assumptions. The proposed model aims to enable the latter by linking empirical performance data to policy redesign.

By combining clarified due diligence standards, risk-based supervision, digital traceability, and joint accountability structures, the integrated governance model addresses the structural limitations identified throughout Tables 1 through 6. Rather than treating self-declaration as a discrete administrative act, the reformed framework institutionalizes continuous regulatory engagement, thereby strengthening preventive capacity and reinforcing regulatory legitimacy over the long term.

6. Discussion

6.1. Theoretical Contributions to Regulatory Governance

This study contributes to regulatory governance scholarship by empirically demonstrating that responsibility allocation functions as a structural determinant of compliance behavior. While prior research has emphasized enforcement intensity and regulatory strategy as primary explanatory variables (Baldwin et al., 2012), the present findings—particularly those summarized in Tables 4 and 5—indicate that regulatory impact is largely mediated through compliance quality and safety management systems. The statistically insignificant direct path between policy intensity and industrial safety performance suggests that formal stringency alone cannot guarantee substantive safety outcomes (Jung, 2018).

These results refine responsive regulation theory (Ayres & Braithwaite, 1992) by showing that enforcement escalation must be embedded within coherent responsibility structures to produce sustainable compliance effects. Moreover, the enforcement-style perspective advanced by Nielsen (2006) helps interpret the mediated effects identified in Table 5: regulatory behavior shapes organizational responses indirectly by influencing how compliance systems are internalized.

By integrating regulatory governance theory with structural path modeling, this study demonstrates that institutional coherence—rather than sanction severity—constitutes the core structural condition for long-term safety performance (Kwon et al., 2024).

6.2. Implications for Korean Occupational Safety Scholarship

The findings extend existing Korean occupational safety research by identifying accountability fragmentation as a systemic constraint on regulatory effectiveness. Previous studies have examined compliance levels and administrative reform efforts (Park et al., 2024; Byun et al., 2024), yet have rarely analyzed how responsibility discontinuity affects life-cycle risk governance.

Descriptive statistics in Table 3 reveal heterogeneous compliance capacities across establishments, while the mediated structural relationships in Tables 4 and 5 indicate that safety management systems are pivotal in translating regulatory intent into operational outcomes. These empirical patterns suggest that institutional fragmentation weakens the internalization of safety norms within regulated entities.

Furthermore, comparative insights drawn from Table

1 and simulation projections in Table 6 illustrate that integrated responsibility models can generate measurable improvements in compliance rates and accident reduction. The discussion therefore shifts the analytical focus from enforcement expansion toward structural realignment of accountability across regulatory actors (Bae, 2024).

6.3. Methodological Reflections and Directions for Future Research

Methodologically, the study demonstrates the utility of structural path modeling in identifying mediated regulatory effects. The measurement validity results reported in Table 2 confirm the robustness of the constructs used to capture compliance quality, safety management, and safety performance. However, the cross-sectional nature of the dataset limits definitive causal inference (Ministry of Employment and Labor, 2024).

Future research should employ longitudinal firm-level data to assess how responsibility restructuring influences compliance trajectories over time. In particular, the long-term effects of digital traceability systems and joint accountability mechanisms—proposed in Section 5—require empirical validation. Comparative case studies examining enforcement style variations, as highlighted by Nielsen (2006), would further interpret how regulatory discretion interacts with institutional design.

Additionally, interdisciplinary research integrating organizational learning theory (Argyris & Schön, 1978) with regulatory governance analysis could clarify how enforcement feedback mechanisms facilitate structural adaptation. Such investigations would deepen understanding of how accountability continuity can be institutionalized in delegated safety governance systems (Jung, 2018).

6.4. Synthesis and Implications

Overall, the discussion underscores that the structural integrity of responsibility allocation constitutes the decisive variable in shaping industrial safety performance, a pattern consistently evidenced across the comparative and structural analyses (see Tables 1–6). By reframing regulatory reform as a problem of accountability coherence rather than enforcement intensity alone, this study provides both theoretical refinement and policy-relevant insight for the evolution of the Self-Declaration Safety Confirmation System under the Occupational Safety and Health Act (Park et al., 2024).

6.5. Limitations of the Study

This study has several limitations. The empirical

analysis is based on secondary data from the 2022 *Survey on Occupational Safety and Health* conducted by the Occupational Safety and Health Research Institute (OSHRI). The sample of 1,247 establishments derives from a nationally validated dataset with statistical representativeness; however, it does not reflect regulatory changes introduced after 2025.

Because this study examines the structural relationships of responsibility and accountability rather than short-term policy effects, the path coefficients reported in Tables 4 and 5 remain theoretically meaningful. Nonetheless, future research should re-test the model using updated longitudinal data to ensure empirical consistency with evolving regulatory conditions.

7. Conclusion

The Self-Declaration Safety Confirmation System represents a significant regulatory innovation under the Occupational Safety and Health Act, marking a transition from centralized command-and-control regulation to delegated compliance governance. By assigning pre-market conformity verification to manufacturers, the system sought to strengthen preventive safety management while improving administrative efficiency. However, this study finds that the structural allocation of responsibility constrains its preventive capacity. Fragmented accountability among manufacturers, user enterprises, and supervisory authorities creates discontinuities across the machinery life cycle, limiting the conversion of formal compliance into substantive safety performance.

Empirical results show that regulatory intensity does not directly enhance industrial safety outcomes; its effect operates through compliance quality and the strength of safety management systems. This mediated structure highlights that coherent responsibility allocation is essential for sustainable safety improvement. Where boundaries of responsibility are unclear, compliance tends to become procedural and documentation-driven, weakening life-cycle risk governance and continuity of accountability.

To address these structural constraints, this study proposes an integrated responsibility governance model that includes clarified due diligence standards, proportionate liability differentiation, transitional joint accountability, digital traceability infrastructure, and risk-based continuous supervision. This framework redefines self-declaration not as a one-time administrative act, but as an ongoing regulatory relationship embedded in continuous oversight.

By reframing reform as a question of accountability

coherence rather than merely stronger enforcement, this study provides both theoretical and policy contributions. Reinforcing continuity of responsibility across institutional actors enhances regulatory legitimacy, promotes internalization of safety norms, and establishes a sustainable foundation for long-term industrial safety performance.

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