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Safety Culture In Enterprises: An Assessment And Intervention Framework Based On A Multi-Model Approach

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ABSTRACT

Safety culture plays a pivotal role in enhancing risk management effectiveness and ensuring workplace safety within enterprises. However, existing studies predominantly apply theoretical models in isolation, limiting their capacity for comprehensive assessment and the design of effective interventions. This paper proposes an integrated multi-model theoretical framework, combining the Schein, Hudson, Reason (Swiss Cheese), and COM-B models, to systematically and comprehensively develop tools for evaluating and intervening in safety culture. The framework facilitates the identification of current conditions, explanation of systemic and behavioral causes, and formulation of sustainable intervention strategies. The study contributes to theoretical advancement while providing practical tools for enterprises to establish more comprehensive and effective safety management strategies. Moreover, the framework lays the groundwork for future empirical research to validate and refine measurement instruments and intervention measures tailored to specific contexts.

Keywords: Safety Culture, Theoretical Framework, Integrated Model, Schein, Hudson, Reason, COM-B

1. Introduction

In the context of globalization and intensifying competition, occupational safety has evolved beyond mere legal compliance to become a critical factor determining the sustainable development of enterprises. Safety culture is widely recognized as an essential foundation for preventing workplace accidents, minimizing risks, and reducing undesirable losses. A positive safety culture not only reflects an organization's commitment to the health and safety of its workforce but also contributes to enhancing productivity, operational efficiency, and long-term competitiveness. In increasingly complex work environments, establishing and maintaining a robust safety culture has become a prerequisite for ensuring sustainable growth.

Although the importance of safety culture has been affirmed in numerous studies, most current research primarily relies on the isolated application of individual theoretical models for assessment or intervention. This approach limits comprehensiveness, making it challenging to fully understand the structure of safety culture, analyze influencing factors, and develop effective intervention strategies. Consequently, there is an urgent need for an

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integrated theoretical framework that is both systematic and adaptable to diverse enterprise contexts.

Classic theoretical models of safety culture, such as Schein's three-level culture model, Hudson's safety culture maturity ladder, Reason's Swiss Cheese model, and the COM-B behavioral framework, each offer valuable insights individually but are often applied in isolation. As a result, each model only captures a partial perspective: Schein's model identifies the underlying cultural depth but lacks behavioral intervention mechanisms; Hudson's model assists in classifying cultural maturity levels but does not address systemic causes of incidents; Reason focuses on analyzing defense gaps without directly considering individual behavior. This gap highlights the need for an integrated approach that connects these models to create a more robust and comprehensive analytical framework.

The primary contribution of this study is the proposal of a multi-model theoretical framework that integrates organizational culture levels, maturity stages, systemic preventive mechanisms, and individual behaviors within a continuous process. This framework not only extends the scope of academic research on safety culture but also provides a foundation for future empirical studies, thereby supporting the reinforcement and advancement of practical safety management in enterprises.

2. Theoretical Foundations

2.1 Overview of Safety Culture

Safety culture is understood as the set of shared values, beliefs, norms, and behaviours related to safety within an organisation. The term was first brought to wide attention in the Chernobyl accident report by the International Atomic Energy Agency (IAEA, 1986) and has since become a central theme in occupational health and safety (OHS) research and practice. Safety culture not only reflects leadership and workforce commitment to safety; it also shapes how an organisation identifies hazards, manages risks, and responds to emerging threats. Empirical studies show that a positive safety culture fosters safer workplaces, lowers incident rates, and enhances operational performance as well as employee satisfaction.

That said, safety culture is a complex construct that is difficult to measure directly and is therefore often examined through various theoretical models. Among these, four prominent frameworks—Schein's organisational culture model, Hudson's safety culture maturity ladder, Reason's Swiss Cheese model, and the COM-B behavioural framework—offer complementary perspectives and can be integrated to build a comprehensive assessment framework.

2.2. Core Theoretical Models

2.2.1. Schein's Organisational Culture Model

Schein (2010) proposed a foundational framework that is widely used to interpret organisational culture in general and safety culture in particular. He differentiates three analytically distinct levels that allow a deeper examination of the layers that make up culture within an organisation:

- **Artifacts.** These are the visible, tangible manifestations of culture—such as documented safe-work procedures, hazard warning signage, personal protective equipment (PPE), and occupational incident/accident reports and statistics. Artifacts are what external observers can readily see, but they represent only the surface of the culture and do not by themselves reveal its underlying nature.
- **Espoused values (espoused beliefs and values).** At this level, culture is conveyed through the strategies, goals, and safety philosophy that the organisation publicly communicates and commits to. Illustrative statements include “Safety comes first” or “Zero tolerance for uncontrolled risk.” However, espoused values may diverge from actual practice if they

are not implemented consistently across the organisation.

- Basic underlying assumptions. This deepest—and most complex—level consists of the tacit, taken-for-granted beliefs and assumptions that shape how members perceive and deal with safety. For example, an organisation may formally prioritise safety, yet a taken-for-granted assumption of “production at all costs” can lead to cutting back on essential control measures. These assumptions strongly influence decisions and behaviours but are rarely articulated or easily recognised.

Strengths. Schein’s model offers a multi-layered analytic lens that penetrates beyond surface indicators to the essence and structure of safety culture. It clarifies gaps between what is declared and what is enacted in day-to-day operations and helps reveal latent, intangible factors that drive safety-related behaviour—thereby providing a solid theoretical basis for more in-depth inquiry.

Limitations. The model is primarily descriptive and diagnostic; it does not prescribe specific interventions for reshaping basic assumptions. Assessing the deeper levels—especially basic underlying assumptions—is difficult given their abstract and non-observable nature, and typically requires time-intensive qualitative methods (e.g., in-depth interviews, observation, ethnographic fieldwork, or document analysis). Moreover, because the framework is broad to organisational culture as a whole, it pays relatively less attention to safety-specific constructs within enterprise settings.

2.2.2. Hudson’s Model (Safety Culture Ladder)

Patrick Hudson’s Safety Culture Ladder (2001) is a widely used classificatory tool that enables organisations to gauge the maturity of their safety culture. Beyond diagnosing the current state, the model lays out a developmental pathway, helping enterprises plan systematic improvement. Hudson depicts culture as evolving across five levels—from Pathological (lowest) to Generative (highest):

- Pathological. Safety is largely disregarded and attracts attention only after major incidents or external scrutiny. The prevailing mindset is that “safety is someone else’s problem,” with frequent blame-shifting and avoidance of responsibility.
- Reactive. The organisation recognises safety’s importance, but action is mainly after-the-fact. Measures are introduced in response to incidents, with limited emphasis on prevention or long-term risk reduction.
- Calculative. Safety is managed through systems, procedures, and metrics. Although controls and statistics proliferate, the approach can become compliance-heavy and number-driven, with insufficient attention to human and behavioural factors.
- Proactive. The organisation anticipates and prevents harm before events occur. Employee participation is encouraged, root-cause analysis is routine, and continuous improvement (e.g., learning from near misses and leading indicators) becomes a guiding principle.
- Generative. Safety is embedded as a core organisational value and integrated into all operations. Everyone takes ownership for risk management, and the enterprise acts as a learning organisation—continually innovating to strengthen hazard control and resilience.

Strengths. The Hudson model offers a clear, intuitive taxonomy that helps organisations locate their current position and chart a development roadmap. It is also practical for benchmarking across firms or tracking a single organisation’s progress over time.

Limitations. The ladder is essentially linear and descriptive, which may understate the complexity and multi-dimensionality of safety culture. It provides limited guidance on *how* to

transition between rungs. Assessment often relies on subjective observation and lacks standardised quantitative measures. Consequently, the model works best when combined with complementary frameworks to create a more comprehensive and granular approach to safety-culture governance.

2.2.3. Reason's Swiss Cheese Model

The Swiss Cheese Model, formulated by James Reason (1997), is a robust explanatory framework for understanding accident causation in complex sociotechnical systems. It portrays each layer of defence within a safety management system—such as policies, procedures, engineering controls/equipment, and supervision/oversight—as a “slice of cheese.”

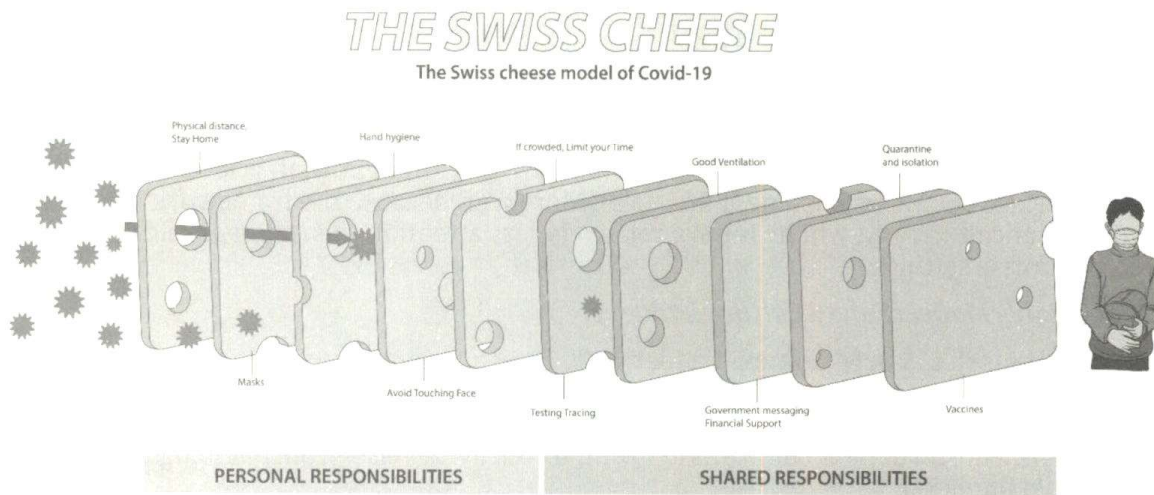


Figure 1. Schematic representation of layered defences in Reason's Swiss Cheese Model.

Each slice of cheese contains “holes”—that is, weaknesses and latent conditions. An accident rarely stems from a single cause; rather, it results from a systemic breakdown when holes across multiple defensive layers inadvertently align, allowing the hazard trajectory to pass through every barrier.

The Swiss Cheese Model is pivotal in shifting attention from individual blame to organisational and system-level factors. Instead of focusing narrowly on “human error,” it emphasises that frontline mistakes are often the final manifestation of dormant weaknesses embedded in the system's design and governance.

Strengths. The model offers a comprehensive view of accident causation, foregrounding organisational contributors instead of attributing events to individuals. It is particularly useful for post-incident analysis and for identifying latent vulnerabilities within defence-in-depth arrangements.

Limitations. The approach is largely reactive, providing limited, concrete guidance for proactive behavioural prevention. Its visuals are intuitive but conceptual, and it lacks standardised quantitative tools to measure and evaluate barrier integrity with precision. Accordingly, it should be combined with complementary frameworks to inform effective, targeted interventions.

2.2.4. The COM-B Behavioural Model

The COM-B framework (Capability–Opportunity–Motivation → Behaviour), introduced by Michie et al. (2011), is a widely applied analytic lens for designing and evaluating

behaviour change. It posits that a given behaviour does not occur in isolation but emerges from the dynamic interaction of three components:

- **Capability** (physical and psychological): the individual's capacity to perform the safe behaviour, encompassing knowledge, procedural skills, and self-efficacy. For example, workers can follow safe operating procedures only when they have received adequate training and have practised the required tasks to competence.
- **Opportunity** (physical and social): external conditions that enable or constrain action—workplace layout and equipment, availability of PPE and tools, staffing levels, time pressure, as well as social norms, supervisory expectations, and a just-culture for reporting. A setting that lacks appropriate protective equipment or discourages incident/near-miss reporting restricts opportunities for safe conduct.
- **Motivation** (reflective and automatic): cognitive and affective drivers—beliefs, attitudes, values, intentions, habits—that energise and direct behaviour. Sustained safe work is more likely when personnel are convinced safety matters, perceive personal and team accountability, and experience supportive cues and feedback.

Strengths. COM-B provides a clear, actionable diagnostic to target interventions at the true constraints on behaviour rather than symptoms. It encourages a holistic programme that acts concurrently on capability, opportunity, and motivation. The model is highly flexible, integrating well with the Theoretical Domains Framework (TDF) and with intervention functions/behaviour-change techniques (e.g., training, enablement, environmental restructuring), which supports practical application in safety training, coaching, and day-to-day OHS management.

Limitations. On its own, COM-B does not fully capture organisational-culture determinants or the governance and systems features that shape safety performance. Its use in occupational settings is comparatively recent, with much of the evidence base originating in healthcare and public health. Accordingly, applying COM-B in enterprises is most effective when combined with complementary frameworks—such as Schein (to surface basic assumptions), Hudson (to gauge cultural maturity), and Reason's Swiss Cheese (to analyse barrier integrity)—to ensure a comprehensive and effective approach to safety management.

3. Integrated Theoretical Framework

The integrated theoretical framework proposed in this study aims to provide a comprehensive instrument for diagnosing, assessing, and intervening to improve safety culture within enterprises. Unlike traditional approaches that rely on a single model, this framework logically links four classic models—Schein, Hudson, Reason, and COM-B—into a systematic cycle of diagnosis → analysis → intervention → improvement. The framework not only locates the current state of safety culture but also surfaces underlying systemic mechanisms and translates cultural values into specific safe behaviours. In doing so, it offers both theoretical value and practical applicability for corporate safety management.

3.1. Integration Logic and Framework Schematic

Safety culture is a multi-dimensional construct in which organisational, system, and individual behavioural factors intertwine and interact. Relying on any single model tends to yield a partial perspective. For example, Schein provides deep cultural analysis but few action pathways; Hudson clarifies maturity levels but does not fully explain systemic failure mechanisms; Reason highlights barrier weaknesses yet offers limited guidance for behaviour change; meanwhile COM-B is strong on behavioural intervention design but does not fully encompass organisational cultural context.

Illustrative example: A construction company may proclaim “safety is our top priority,” yet under schedule pressure supervisors permit work at height without fall-arrest systems. This shows that while safety slogans (visible artifacts) exist, the basic underlying assumption still prioritises production. Viewed through a single lens, the linkage between espoused claims, day-to-day practice, and frontline behaviour is easily missed.

To address these gaps, the integrated framework is structured as a process that combines the strengths of each model:

- Foundational diagnosis: map cultural structure and position the organisation on the maturity continuum (Schein & Hudson).
- Systems analysis: identify barrier vulnerabilities and failure pathways across layers of defence (Reason).
- Behavioural intervention: design targeted measures that act on Capability, Opportunity, and Motivation to embed sustained safe behaviour (COM-B).

The framework functions as a closed-loop: intervention outcomes not only remedy current weaknesses but also feed back to reshape cultural assumptions and elevate the organisation’s maturity level. In short, it moves beyond “fixing faults” to drive continuous improvement in safety culture.

3.2. Stage 1: Baseline Assessment

The opening stage lays the foundation by providing a holistic view of the organisation’s prevailing safety culture. Schein’s model is applied to explore the three cultural strata:

- Tangible artefacts (artifacts): observable manifestations such as safety slogans, PPE, accident statistics, and operating procedures.
Example: a mechanical workshop displaying house rules, “No Smoking” signs, and mandatory-PPE lists throughout the shopfloor.
- Espoused values: the organisation’s formal declarations (e.g., “safety is our top priority”). In practice, many firms hang banners with such slogans but lack robust oversight mechanisms to ensure consistent implementation.
- Basic underlying assumptions: tacit, hard-to-surface beliefs that drive actual behaviour (e.g., “production outweighs safety”).
Example: in some mining operations, workers believe that “if targets aren’t met, safety doesn’t matter,” which silently shapes day-to-day decisions.

Combined with Hudson’s Safety Culture Ladder, these insights are used to position the organisation on the maturity continuum from *Pathological* to *Generative*. Knowing the current rung clarifies the gap to the desired state.
Illustration: if garment-factory staff wear PPE only when inspectors are present, the organisation is likely at a Reactive level. Conversely, if operators in a power plant voluntarily report near-misses to prevent recurrence, the enterprise is approaching Proactive/Generative maturity.

The value of this stage is the creation of a “cultural map”—a clear statement of the starting point that underpins the system analysis performed in the next stage.

3.3. Stage 2: Systemic Gap Analysis

Once cultural positioning is established, the next step is to analyse system failure mechanisms using Reason’s Swiss Cheese Model. In this view, every organisation maintains multiple layers of defence—policies, procedures, technology/engineering controls, and supervision—each containing latent “holes.” When these holes inadvertently align, hazards can penetrate all barriers and precipitate serious incidents.

Linking Hudson and Reason helps identify gap types characteristic of each maturity level:

- Lower maturity (Pathological/Reactive): gaps often involve weak leadership commitment, perfunctory supervision, or responsibility avoidance. *Example:* on a construction site, a supervisor routinely skips scaffold inspections because “we’ve done this a hundred times.”
- Mid maturity (Calculative): gaps appear when the safety management system (SMS) exists largely on paper; metrics abound but are not used for learning or improvement. *Example:* a chemical plant records every minor incident but never analyses the dataset to detect emerging risk trends.
- Higher maturity (Proactive/Generative): gaps are subtler and stem from complex cross-functional interactions, information misalignment, or latent design issues. *Example:* in a hospital, the fire-alarm system is linked to the control centre but not integrated with emergency power, creating a risk of non-activation during a total power loss.

This stage therefore not only surfaces system vulnerabilities but also anchors them to a specific cultural maturity level, enabling a targeted, staged intervention roadmap.

3.4. Stage 3: Behavioural Intervention and Shaping

Building on the systemic gaps identified earlier, the final stage focuses on designing behaviour-change interventions using the COM-B framework. This is where conceptual findings are translated into practical actions that embed sustained safe behaviour.

According to COM-B, safe behaviour depends on three interacting components:

- Capability: ensuring workers possess the knowledge, skills, and self-efficacy required to act safely. *Example:* electrical lineworkers need hands-on training in fault isolation and response to short-circuit events (not classroom theory alone) to execute procedures correctly.
- Opportunity: creating favourable physical and social conditions—a safe work environment, adequate PPE at point of use, non-punitive reporting mechanisms, and a supportive safety climate. *Example:* in hospitals, placing alcohol hand rub at the head of each bed increases the opportunity for staff to comply with hand-hygiene protocols.
- Motivation: strengthening reflective and automatic drivers—beliefs, attitudes, values, habits—that energise safe action. *Example:* internal safety communications, fair incentive schemes, and visible leadership role-modelling; in mining, recognising teams that submit high-quality near-miss reports to encourage prevention rather than punishing incident disclosure.

The distinctive value of COM-B lies in its ability to convert values into routines, helping organisations not only to patch system weaknesses but to normalise safety in daily work. When integrated into the closed loop, these interventions generate feedback that reshapes basic assumptions and progressively raises cultural maturity over the long term.

3.5. Overall Significance of the Integrated Framework

This integrated framework offers three major contributions:

- Theoretical: it forges a bridge between organisational culture (Schein, Hudson), system safety (Reason), and behavioural science (COM-B).

- Practical: it supplies a clear improvement pathway—from identifying root causes to changing behaviour.
Example: a small mechanical workshop might surface the underlying assumption “schedule over safety” (Schein), place itself at a Reactive level (Hudson), locate supervision gaps in PPE enforcement (Reason), then intervene with targeted training and motivation measures for operators (COM-B).
- Applied: it is adaptable across sectors—especially high-hazard domains such as construction, chemicals, energy, and healthcare. In construction it supports control of work at height; in healthcare it reduces clinical incidents; in chemicals it helps prevent toxic releases; in energy it strengthens the resilience of complex systems and their barriers.

In sum, the framework enables enterprises to diagnose the current state and systemic causes of accidents while charting a sustainable improvement strategy—transforming safety culture from a slogan into an indispensable element of everyday operations.

4. Discussion

This section probes more deeply into the contribution of the integrated theoretical framework, clarifies its advantages over traditional single-model approaches, and considers its implications for both scholarship and practice.

4.1. Strengths and Novelty of the Integrated Framework

The multi-model framework advanced in this study offers an unprecedented, systematic, and truly holistic approach to governing safety culture. Rather than relying on one model—as many prior studies have done—it links four core perspectives into a closed, iterative cycle. In combination, Schein illuminates cultural foundations, Hudson positions cultural maturity, Reason reveals system-level failure mechanisms, and COM-B targets individual behaviour change.

This integration counters the partial views that arise when a single lens is used. For instance, an organisation assessed as Calculative on Hudson’s ladder may have extensive documented procedures; the integrated framework then asks: do day-to-day practices genuinely reflect those procedures (Schein)? where are the barrier weaknesses (Reason)? and do workers possess the Capability, Opportunity, and Motivation to enact the required safe behaviours (COM-B)? Managers are therefore enabled not only to see where they are, but to understand why they are there and what precise actions will shift performance sustainably—moving beyond symptom treatment to root-cause resolution.

4.2. Comparison with Previous Research

Earlier safety-culture research generally clusters into two camps: (i) descriptive/diagnostic work on culture, and (ii) behaviour-change interventions. Many studies use Hudson-based surveys to position maturity but offer limited methods for explaining deeper causes or prescribing actionable improvements. Conversely, COM-B-driven programmes sometimes reshape behaviour without embedding it in the wider cultural context.

The proposed framework bridges this divide by connecting cultural diagnosis with behavioural intervention. Its multi-level linkage—from basic assumptions to maturity level, to barrier integrity, and ultimately to frontline behaviour—yields a coherent theory of change with greater practical utility than prior, more fragmented approaches. Researchers and practitioners can thus interrogate not only isolated factors but also the interactions among them.

4.3. Theoretical and Practical Implications

Theoretical implications. The study contributes a synthesised model that demonstrates complementarity among theories originally developed in parallel. It extends understanding of how safety culture operates by integrating insights from organisational management, system safety, and behavioural science, thereby strengthening the basis for future interdisciplinary research.

Practical implications. Although conceptual, the framework functions as a robust managerial tool, offering a clear roadmap to:

1. Diagnose accurately: pinpoint strengths and weaknesses in an organisation's safety culture.
2. Analyse root causes: move beyond "human error" to uncover deeper, system-level issues.
3. Design targeted interventions: direct resources efficiently towards specific constraints in Capability, Opportunity, and Motivation.

4.4 Limitations and Directions for Future Research

The principal limitation is the study's theoretical nature. The integrated framework has not yet been validated with organisation-level empirical data. While its constituent models are well supported, their combination warrants evaluation in real settings.

Future work should therefore prioritise empirical testing across multiple sectors—manufacturing, construction, healthcare, energy—to assess effectiveness and transferability. Such studies can refine the framework, identify contextual moderators, and develop fit-for-purpose quantitative instruments to operationalise measurement and monitoring, enabling more rigorous application in practice.

Conclusion

This study proposes a new integrated framework that delivers a comprehensive and systematic approach to diagnosing and intervening in safety culture within enterprises. By logically connecting Schein, Hudson, Reason, and COM-B, the framework enables precise assessment of the current cultural state, deeper analysis of systemic causes, and the design of behaviourally targeted interventions. It advances the literature by demonstrating the mutual reinforcement of these models and provides a coherent tool for researchers. Simultaneously, it offers substantial practical value to managers and OHS professionals—supporting a strategic shift from mere compliance to a sustainable safety culture. Although conceptual at this stage, the framework lays a solid foundation for future empirical validation and refinement in real-world organisational contexts.

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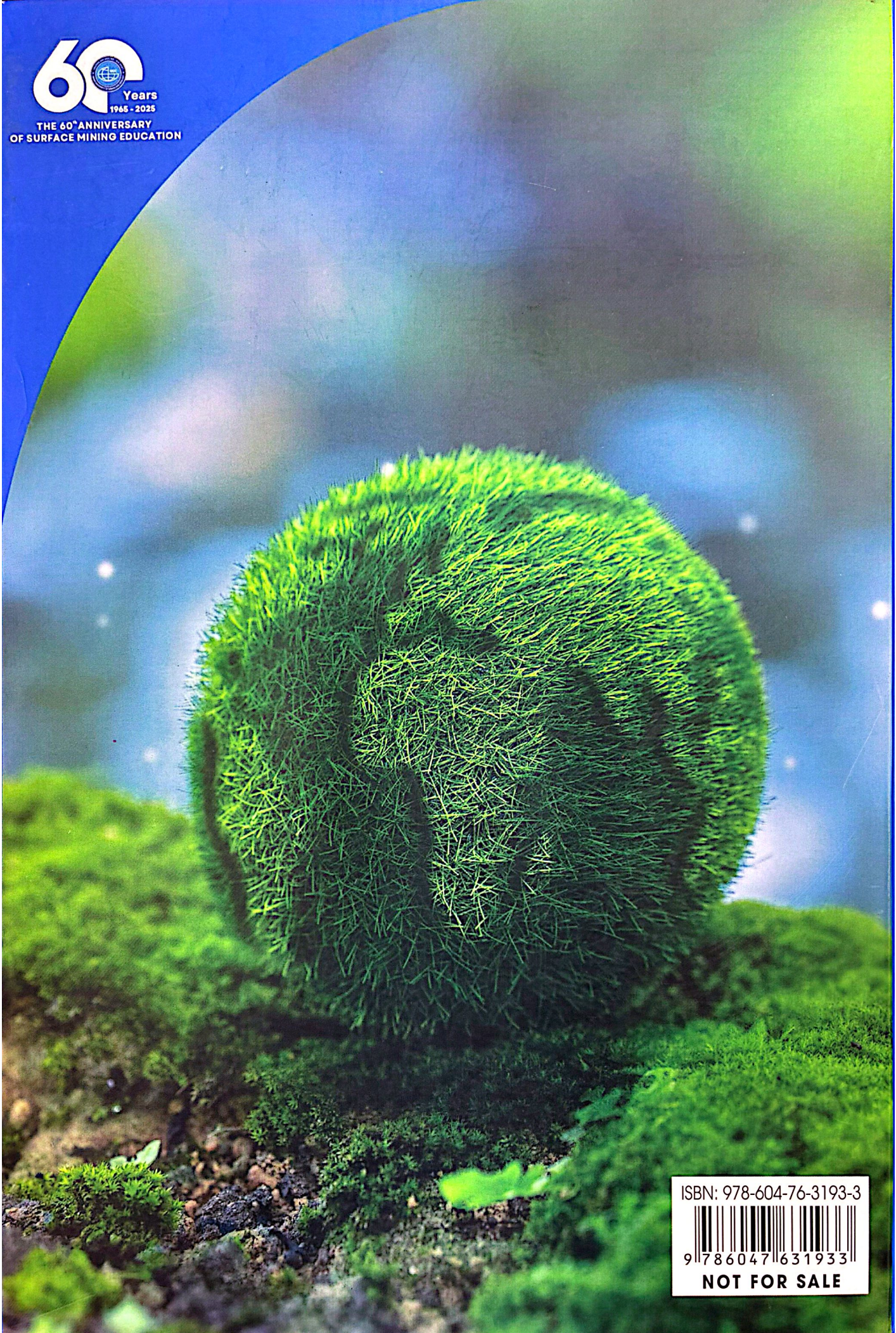
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