

A DEMATEL-Based Systems Analysis of Health and Safety Risk Drivers Among Marginalized Worker Populations¹

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Abstract

Occupational health and safety (OHS) risks among marginalised workers are shaped not only by unsafe working conditions, weak regulation, and socio-economic vulnerability, but also by unequal communication systems that limit access to safety information, hazard reporting channels, training, and worker participation. Informal labourers, migrant workers, and socioeconomically disadvantaged groups often work in settings where safety messages are poorly disseminated, linguistically inaccessible, inconsistently enforced, or disconnected from workers' lived realities. The objective of this study is to identify and analyse the interdependent risk drivers influencing OHS outcomes among marginalised workers through a communication-sensitive systems perspective. The study applies the Decision-Making Trial and Evaluation Laboratory (DEMATEL) method to examine 17 critical risk factors identified through literature review and field-based investigation and evaluated by seven domain experts.

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The findings indicate that regulatory exclusion, employment informality, and inadequate access to safety training are key causal drivers of occupational vulnerability. Communication-related factors, including language barriers, weak supervision, lack of union representation, limited worker participation, and low safety compliance, further intensify risk by disrupting the flow, understanding, trust, and use of safety information. The study contributes to occupational health communication, risk communication, organisational communication, and communication for social change by showing that OHS risks among marginalised workers are also communication inequalities embedded in labour structures and institutional practices. The findings support inclusive safety communication, participatory training, multilingual risk messaging, and worker-centred reporting mechanisms.

Keywords: occupational health and safety; risk communication; marginalised workers; communication inequality; participatory communication; health communication; organisational communication; DEMATEL; informal labour; worker participation

Occupational health and safety (OHS) risks remain a critical concern for marginalised worker populations, particularly informal labourers, migrant workers, contract workers, and socioeconomically disadvantaged groups (Panikkar et al., 2015). These workers frequently operate outside formal systems of labour protection and are exposed to unsafe work environments, inadequate safety training, weak enforcement of regulations, limited healthcare access, and unstable employment conditions (Sverdlik et al., 2024). Such risks are especially severe in informal and low-regulated work settings, where occupational injuries, toxic exposure, fatigue, discrimination, and poor safety compliance are often normalised rather than systematically addressed (AREO et al., 2025).

Existing studies have widely recognised that marginalised workers face heightened occupational vulnerability because of regulatory exclusion, employment informality, socio-economic insecurity, and limited access to institutional support (Lund et al., 2016). However, OHS risks are not only produced by physical hazards or legal gaps. They are also shaped by communication processes. Workers need clear, timely, trusted, and understandable information about workplace hazards, safety practices, protective equipment, emergency procedures, and reporting mechanisms (Pucheta & Kalil, 2025). When such communication is absent, inaccessible, one-directional, or controlled by unequal power structures, workers become less able to identify hazards, report unsafe conditions, participate in safety decisions, or comply with preventive practices (Alam et al., 2022).

The communication dimension is particularly important in the case of marginalised workers. Language barriers, low literacy, fear of job loss, migrant status, lack of union representation, weak supervision, and workplace discrimination can prevent workers from receiving and acting upon safety information (AlMarri et al., 2025). In many informal workplaces, safety communication is not institutionalised through formal training, written protocols, feedback channels, or participatory dialogue. Instead, workers often rely on informal instructions, peer-based learning, or fragmented information from supervisors and contractors. Such conditions create communication inequalities, where some workers have access to safety knowledge and decision-making power while others remain excluded from the information systems necessary for protecting their health and safety (Moyce & Schenker, 2018).

From a communication perspective, occupational risk is therefore not merely a matter of individual behaviour or technical control. It is also a matter of how risk information is produced, transmitted, interpreted, trusted, negotiated, and acted upon within unequal organisational and social contexts. Risk communication helps explain whether workers

understand the nature and severity of workplace hazards (Caxaj et al., 2023; Grabill & Simmons, 1998). Health communication helps explain how safety training and preventive messages influence health-related behaviour (Scott & Trethewey, 2008). Organisational communication helps explain how employers, supervisors, contractors, and workers exchange safety-related information within workplace hierarchies (Real, 2008). Participatory communication highlights the importance of involving workers in identifying hazards and designing safety interventions (Scheer et al., 2014). Communication for social change further emphasises the need to empower marginalised workers through inclusive dialogue, collective voice, and institutional accountability (Ghio et al., 2021).

Despite the relevance of communication to OHS outcomes, much of the existing research on worker safety has focused either on individual risk factors or on technical and regulatory dimensions of safety management (Lingard et al., 2019). Conventional linear approaches often fail to capture the interdependent nature of occupational risk drivers. For example, inadequate safety training may be connected to language barriers, weak supervision, employment informality, low safety compliance, and limited worker participation. Similarly, regulatory exclusion may reduce access to formal safety information, weaken reporting systems, and intensify workers' dependence on informal channels of communication (Acheampong et al., 2025). These relationships suggest the need for a systems-based method capable of identifying causal linkages among structural, organisational, behavioural, and communication-related risk factors.

To address this gap, the present study applies the Decision-Making Trial and Evaluation Laboratory (DEMATEL) method to analyse the causal relationships among key OHS risk drivers affecting marginalised worker populations. DEMATEL is suitable for examining complex systems because it identifies not only the relative importance of different factors but

also the direction and strength of influence among them. In this study, DEMATEL is used to map how structural factors such as regulatory exclusion and employment informality interact with communication-linked factors such as inadequate safety training, language barriers, lack of union representation, weak supervision, low safety compliance, and limited access to healthcare.

The study is guided by the following objectives:

1. To identify major occupational health and safety risk factors affecting marginalised worker populations.
2. To examine the causal relationships among structural, organisational, behavioural, and communication related OHS risk drivers.
3. To classify the identified factors into causal and dependent groups using the DEMATEL method.
4. To explain how communication inequalities influence safety training, regulatory compliance, hazard reporting, and worker participation.
5. To suggest communication-oriented and policy-relevant interventions for improving OHS outcomes among marginalised workers.

This study contributes to the ICA conference theme by positioning occupational safety as a communication-sensitive system. While the methodological core of the paper lies in DEMATEL-based systems analysis, the substantive contribution lies in showing that OHS vulnerability among marginalised workers is strongly influenced by unequal access to safety information, weak communication channels, limited participation, and exclusion from institutional dialogue. The paper therefore connects occupational health management with risk communication, health communication, organisational communication, participatory communication, and communication for social change.

Theoretical Framework

A Communication-Sensitive Systems Perspective on OHS

This study is grounded in a communication-sensitive systems perspective, which views occupational health and safety risks among marginalised workers as the outcome of interconnected structural, organisational, behavioural, and communicative conditions (Xiao et al., 2025). The original framework draws on systems theory, Social Determinants of Health, risk society theory, risk communication, health communication, organisational communication, participatory communication, and communication for social change (Mucci et al., 2020).

Systems theory provides the foundation for understanding OHS risks as interdependent rather than isolated (Appelbaum, 1997). In marginalised labour settings, factors such as regulatory exclusion, employment informality, inadequate safety training, weak supervision, low safety compliance, and language barriers interact with one another and create cumulative occupational vulnerability (Sony & Naik, 2020). This justifies the use of DEMATEL, as the method helps identify which factors act as causal drivers and which factors are dependent outcomes within the overall risk system.

The Social Determinants of Health framework explains how socio-economic vulnerability, migrant status, poor housing, limited healthcare access, discrimination, and job insecurity influence workers' exposure to occupational risks and their ability to respond to them. These conditions are not only economic or social disadvantages; they also restrict workers' access to safety information, health services, reporting systems, and workplace participation.

Risk society theory further supports the study by explaining how modern labour systems distribute occupational risks unequally. Informal and migrant workers often bear higher safety risks because they are excluded from formal regulation, legal protection, and

institutional accountability (Cooper, 2008). In this context, regulatory exclusion and employment informality become structural causes of occupational vulnerability.

Risk communication and health communication are central to the communication orientation of the study. Workers' safety behaviour depends on how risk information is communicated, understood, trusted, and acted upon. Inadequate safety training, language barriers, unclear hazard warnings, and weak communication about protective measures reduce workers' (Wu et al., 2017) ability to recognise risks and adopt safe practices. Therefore, safety training is treated not merely as an administrative activity but as a health communication process.

Organisational communication explains how safety-related information flows between employers, supervisors, contractors, safety officers, and workers (Wu et al., 2017). Weak supervision, poor hazard control, low safety compliance, and unclear reporting channels reflect failures in workplace communication. Effective OHS management requires two-way communication, regular feedback, clear responsibilities, and trust-based reporting systems. Participatory communication and communication for social change highlight the importance of worker voice and inclusion. Marginalised workers are often excluded from safety decision-making due to job insecurity, discrimination, migrant status, and lack of union representation (Buchholz et al., 2009). A participatory approach recognises workers as active contributors to hazard identification, safety training, reporting mechanisms, and workplace improvement.

Taken together, these perspectives frame OHS risks as communication-sensitive and systemically produced. The 17 risk factors used in the DEMATEL analysis are therefore interpreted not only as technical or policy variables but also as communication-linked determinants (Si et al., 2018). Structural factors such as regulatory exclusion, employment informality, socio-economic vulnerability, and poor housing conditions interact with

communication-related factors such as inadequate safety training, language barriers, weak supervision, lack of union representation, low safety compliance, and workplace discrimination. This framework supports the study's central argument that improving OHS outcomes among marginalised workers requires not only stronger regulation and better hazard controls but also inclusive, multilingual, participatory, and trust-based safety communication systems.

Table 1

Theoretical Mapping of Identified 17 Risk Factors

ID	Risk Factor	Relevant Theoretical Perspective	Theoretical Interpretation
R1	Regulatory Exclusion	Risk Society Theory; Communication for Social Change; Systems Theory	Explains how institutional exclusion creates unequal exposure to occupational risks and limits workers' access to formal safety communication, grievance systems, and legal protection.
R2	Employment Informality	Social Determinants of Health; Systems Theory	Reflects how insecure employment conditions reduce access to training, safety information, reporting channels, insurance, and workplace protection.
R3	Inadequate Access to Safety Training	Risk Communication; Health Communication; Organizational Communication	Represents a core communication failure where workers do not receive clear, usable, repeated, and context-sensitive safety information.
R4	Poor Workplace Hazard Controls	Systems Theory; Safety Management; Organizational Communication	Shows how weak organizational systems and poor communication of hazard-control responsibilities increase exposure to unsafe conditions.
R5	Low Safety Compliance	Risk Communication; Health Communication; Organizational Communication	Indicates that compliance depends not only on rules but also on how safety messages are communicated, understood, trusted, and reinforced.

Table 1

Theoretical Mapping of Identified 17 Risk Factors (Contd.)

ID	Risk Factor	Relevant Theoretical Perspective	Theoretical Interpretation
R6	Limited Access to Healthcare	Social Determinants of Health; Health Communication	Highlights how unequal access to medical care and poor communication about health services worsen post-injury outcomes.
R7	Socio-Economic Vulnerability	Social Determinants of Health; Risk Society Theory	Explains how poverty and insecurity force workers to tolerate unsafe work and reduce their ability to demand safety rights.
R8	Lack of Union Representation	Participatory Communication; Communication for Social Change	Indicates absence of collective voice, worker participation, negotiation platforms, and institutional dialogue on safety concerns.
R9	Language Barriers	Risk Communication; Health Communication; Communication Inequality	Directly reflects communication inequality, where safety instructions, warning signs, and training may not be understood by migrant or multilingual workers.
R10	Migrant Status	Social Determinants of Health; Communication Inequality; Risk Society Theory	Explains how migrant workers face legal, linguistic, social, and informational barriers in accessing safety systems and reporting hazards.
R11	Inadequate Supervision	Organizational Communication; Systems Theory	Shows weak downward and upward communication between supervisors and workers, affecting monitoring, feedback, correction, and safety reinforcement.
R12	Workplace Discrimination	Communication for Social Change; Social Determinants of Health	Reflects power inequality and exclusion, where workers may be silenced, ignored, or discouraged from reporting unsafe conditions.
R13	Job Insecurity	Risk Society Theory; Participatory Communication	Explains why workers may avoid speaking up about hazards or non-compliance due to fear of job loss or retaliation.

Table 1

Theoretical Mapping of Identified 17 Risk Factors (Contd.)

ID	Risk Factor	Relevant Theoretical Perspective	Theoretical Interpretation
R14	Overcrowded Workspaces	Systems Theory; Social Determinants of Health	Represents a structural workplace condition that interacts with poor communication, weak supervision, and limited hazard control.
R15	Unsafe Working Hours	Social Determinants of Health; Safety Management	Shows how long or irregular hours increase fatigue and reduce workers' ability to process, remember, and follow safety information.
R16	Exposure to Toxic Substances	Risk Communication; Health Communication; Systems Theory	Requires effective hazard communication, warnings, protective instructions, and health-risk awareness to prevent exposure-related harm.
R17	Poor Housing Conditions	Social Determinants of Health; Communication for Social Change	Extends OHS beyond the workplace by showing how poor living conditions affect health, vulnerability, and access to institutional support.

Review of Literature

Occupational health and safety risks among marginalised workers have been widely examined in relation to precarious employment, weak labour protection, unsafe working conditions, poor access to healthcare, and socio-economic vulnerability (Sverdlik et al., 2024). Informal labourers, migrant workers, contract workers, domestic workers, and other disadvantaged occupational groups are often located outside formal safety systems and therefore face higher exposure to workplace hazards, toxic substances, fatigue, discrimination, and job insecurity (Gill et al., 2024). Existing literature shows that factors such as regulatory exclusion, employment informality, inadequate safety training, poor hazard controls, low safety

However, much of the existing OHS literature treats these risks mainly as regulatory, managerial, or behavioural issues. This approach is useful but incomplete because occupational safety is also shaped by communication processes. Workers must receive, understand, trust, and act upon safety information. They also need safe channels to report hazards, ask questions, participate in safety discussions, and communicate workplace concerns without fear of retaliation. When safety communication is unclear, inaccessible, one-directional, or disconnected from workers' lived realities, occupational risk increases even where formal safety rules exist.

Communication Inequality and Worker Safety

Communication inequality is a critical but underdeveloped dimension in OHS research on marginalised workers (Pucheta & Kalil, 2025). It refers to unequal access to safety information, unequal ability to understand safety messages, and unequal opportunity to participate in safety-related decision-making. Among informal and migrant workers, this inequality appears through language barriers, low literacy-sensitive safety materials, irregular training, unclear hazard warnings, weak supervision, and inaccessible reporting mechanisms. Inadequate safety training, therefore, should not be viewed only as an administrative gap. It is also a communication failure. Similarly, language barriers directly affect workers' ability to understand risks, follow safety instructions, and report hazards. Weak supervision reflects poor organisational communication because supervisors often act as the main link between management and workers. Lack of union representation further limits participatory communication and reduces workers' collective voice in safety matters. These factors show that communication inequality can intensify occupational vulnerability by restricting the flow, interpretation, trust, and use of safety information.

Risk Communication, Health Communication, and Organisational Communication

Risk communication theory is relevant to OHS because workers' responses to hazards depend on how risks are communicated (Grabill & Simmons, 1998). Effective risk communication requires clarity, accessibility, trust, cultural relevance, repetition, and feedback. In marginalised labour settings, safety messages may be delivered in unfamiliar languages, presented in technical formats, or communicated as top-down instructions without worker dialogue. Such communication weaknesses reduce risk awareness and weaken safety compliance.

Health communication further explains how preventive messages, safety training, protective equipment instructions, emergency procedures, and healthcare-related information influence workers' safety behaviour. If these messages are not understandable or actionable, they are unlikely to produce meaningful behavioural change. Low safety compliance should therefore not be interpreted only as worker negligence; it may also reflect poor communication design, fear of retaliation, lack of trust in employers, or exclusion from safety decision-making. Organisational communication also plays a central role in workplace safety. In effective safety systems, information flows through training sessions, safety committees, signage, reporting channels, audits, and supervisor feedback. In informal or weakly regulated workplaces, these systems are often absent or inconsistent. Poor organisational communication can create unclear safety responsibilities, weak hazard reporting, inadequate supervision, and limited corrective action.

Participatory Communication and Communication for Social Change

Participatory communication offers an important corrective to top-down safety management. It emphasises that workers should not be treated merely as passive recipients of safety instructions but as active participants in identifying hazards, reporting unsafe conditions, and shaping safety solutions. Marginalised workers often possess practical knowledge of

workplace risks, but their voices are frequently excluded due to migrant status, job insecurity, discrimination, weak bargaining power, and lack of union representation.

Communication for social change extends this argument by linking safety communication with empowerment, collective voice, and institutional accountability. Improving OHS among marginalised workers requires more than safety posters or training manuals. It requires inclusive communication systems through which workers can access information, report violations, participate in decision-making, and demand safer working conditions.

DEMATEL and the Need for a Communication-Sensitive Systems Approach

The DEMATEL method has been widely applied to examine complex systems and identify causal relationships among interdependent factors. In OHS research, DEMATEL is useful because workplace risks rarely operate independently. For example, employment informality may reduce access to safety training; inadequate training may weaken compliance; language barriers may reduce the effectiveness of training; and lack of union representation may limit hazard reporting. DEMATEL is therefore appropriate for identifying root drivers and dependent outcomes within the wider safety-risk system.

Nevertheless, previous DEMATEL-based OHS studies have mainly focused on technical, managerial, operational, or safety-climate factors. Limited attention has been given to marginalised worker populations, and even less to communication inequality as a causal mechanism affecting occupational safety. This creates a clear research gap. Existing studies recognise that informal and migrant workers face high OHS vulnerability, but they do not sufficiently explain how communication barriers interact with structural and organisational risk factors to shape safety outcomes. The present study addresses this gap by applying DEMATEL through a communication-sensitive systems perspective. It examines 17 OHS risk factors as interconnected structural, organisational, behavioural, and communication-linked determinants.

Structural factors such as regulatory exclusion, employment informality, socio-economic vulnerability, migrant status, and poor housing conditions are examined alongside communication-linked factors such as inadequate safety training, language barriers, weak supervision, lack of union representation, low safety compliance, and workplace discrimination.

Research Gap

The reviewed literature reveals three key gaps. First, existing OHS studies identify several risks affecting marginalised workers but often examine them separately rather than as an interdependent system. Second, communication scholarship has not been sufficiently integrated into OHS research, despite the importance of safety information, hazard communication, worker voice, and participatory dialogue. Third, previous DEMATEL applications in OHS have rarely foregrounded communication inequality as a causal driver of occupational vulnerability.

This study responds to these gaps by combining DEMATEL with a communication-sensitive theoretical lens. It contributes to occupational health communication by showing how structural exclusion and communication inequality jointly shape safety risks among marginalised workers. It also offers a systems-based basis for designing inclusive safety communication strategies, multilingual training systems, participatory hazard-reporting mechanisms, and policy interventions for vulnerable labour groups.

Methodology

This study adopted a communication-sensitive systems approach using the Decision-Making Trial and Evaluation Laboratory method to analyse occupational health and safety risk drivers among marginalised workers. The methodology involved four stages: identification of risk factors, field-based validation, expert evaluation, and DEMATEL-based causal analysis.

The study focused on 17 risk factors affecting marginalised workers, including regulatory exclusion, employment informality, inadequate safety training, language barriers, low safety compliance, weak supervision, lack of union representation, and limited healthcare access.

Literature Review and Risk Factor Identification

A structured literature review was conducted to identify major occupational health and safety risks among informal, migrant, contract, and socioeconomically vulnerable workers. Relevant literature was searched through databases such as Scopus, Web of Science, PubMed, Google Scholar, ScienceDirect, and SpringerLink. Keywords included “occupational health and safety,” “marginalised workers,” “informal labour,” “migrant workers,” “risk communication,” “safety training,” “language barriers,” “hazard reporting,” and “worker participation.”

Studies were included if they addressed occupational safety, vulnerable workers, communication barriers, safety compliance, training, regulatory exclusion, or workplace hazards. Studies unrelated to OHS, marginalised labour, communication, or safety management were excluded. The review helped identify an initial set of risk factors, which was refined into 17 final factors.

Field Investigation and Contextual Validation

Field-based investigation was used to validate the practical relevance of the identified risk factors. Inputs were collected through workplace observations, informal interactions with labour stakeholders, and structured survey responses from workers, supervisors, and safety-related personnel. A purposive sampling approach was used because the study focused on vulnerable worker groups and informal or weakly regulated work settings.

The field investigation examined workers’ exposure to hazards, access to safety training, availability of reporting channels, language-related barriers, safety compliance,

healthcare access, discrimination, and job insecurity. These inputs were used for contextual validation of the risk factors and not for statistical generalisation.

Expert Panel and Data Collection

Seven domain experts were selected through purposive expert sampling. The panel included experts from occupational safety, labour policy, industrial management, public health, environmental safety, migrant worker welfare, and health systems. Experts were selected based on professional experience, subject knowledge, familiarity with marginalised worker safety, and ability to assess interrelationships among risk factors.

Each expert evaluated the direct influence of one risk factor on another using a five-point scale: 0 = no influence, 1 = low influence, 2 = moderate influence, 3 = high influence, and 4 = very high influence. Individual expert matrices were aggregated using mean values to construct the initial direct-relation matrix.

Table 2

Profile of Experts and Role in the Study

Expert ID	Experience (Years)	Expertise	Background/Field	Role in Study
1	15+	Occupational Safety and Risk Management	Occupational Safety Management	Assessed safety hazards and risk management practices in marginalised sectors.
2	10+	Labour Policy and Employment Law	Labour Economics and Policy	Provided insights on labour regulations and informal sector risks.
3	5+	Industrial Management and Safety Compliance	Industrial Engineering and Safety	Evaluated safety compliance metrics and hazard exposure in informal sectors.

Table 2

Profile of Experts and Role in the Study (Contd.)

Expert ID	Experience (Years)	Expertise	Background/Field	Role in Study
4	15+	Social Determinants of Health	Public Health and Sociology	Focused on socio-economic vulnerabilities and their impact on OHS outcomes.
5	10+	Environmental Health and Safety	Environmental Science and Safety	Contributed to the assessment of environmental hazards and toxic substance exposure.
6	>5	Migrant Worker Rights and Welfare	Labour Rights and Humanitarian Studies	Provided expertise on the specific risks faced by migrant workers.
7	5+	Health Systems and Public Policy	Health Systems and Policy Analysis	Analysed healthcare access and its relation to OHS risks in marginalised groups.

DEMATEL Procedure

The DEMATEL analysis followed standard steps. First, the direct-relation matrix was constructed from expert scores. Second, the matrix was normalised. Third, the total-relation matrix was calculated. Fourth, row sums and column sums were derived to obtain prominence and relation indices. The prominence value shows the overall importance of each factor, while the relation value classifies factors into causal and dependent groups (Si et al., 2018).

This procedure enabled the study to identify key causal drivers of occupational vulnerability and to interpret them through occupational health, communication, and systems perspectives.

Validity, Reliability, and Ethics

Content validity was ensured by deriving factors from literature and validating them through field investigation and expert review. Expert consistency was checked through a review of divergent responses and clarification of unclear ratings. Ethical safeguards were followed by ensuring voluntary participation, anonymity, confidentiality, and non-disclosure of personal identities. Since the study involved marginalised workers, care was taken to avoid collecting sensitive information that could create employment or social risk.

The methodology is suitable for conference proceedings because it provides a concise but transparent explanation of factor identification, expert assessment, DEMATEL analysis, and ethical safeguards.

Results and Discussion

The application of the Decision-Making Trial and Evaluation Laboratory (DEMATEL) method revealed a complex web of interdependencies among the identified risk factors influencing Occupational Health and Safety (OHS) outcomes among marginalised worker populations. Through expert evaluations, we constructed a direct-relation matrix, which was normalised to generate a total-relation matrix. From this matrix, we calculated the prominence–relation indices ($D + R$ and $D - R$) for each risk factor, which helped identify the primary causal drivers and dependent factors. The Direct Normalization Matrix is an essential component of the DEMATEL methodology, used to assess the influence of one risk factor on another. It is based on pairwise influence scores, which represent the expert judgment of how one factor influences another within the system (Paramaiah et al., 2026). These scores are typically provided on a Likert scale ranging from 0 (no influence) to 4 (very high influence). The goal

of the Normalization process is to transform these raw scores into a comparable scale that allows for the evaluation of the relative influence of each risk factor in the system. Normalization involves two primary steps:

Step 1: Summing the values of each column in the direct-relation matrix. This provides a sense of the total influence each factor exerts over all other factors.

Step 2: Dividing each cell value in the direct-relation matrix by the sum of its respective column to normalize the values. This ensures that the influence scores are scaled in a way that is consistent across all factors, facilitating direct comparisons.

The expert evaluations were aggregated to form a direct-relation matrix as shown in Table 3, which represents the direct influence of one factor on another. The matrix captures the interactions between risk factors as assessed by the expert panel.

Once the Normalised Direct-Relation Matrix is computed, the next step is to derive the Prominence-Relation Indices ($D + R$ and $D - R$). These indices are key metrics in the DEMATEL method, used to assess the overall influence and dependency of each risk factor within the system.

Prominence Index ($D+R$): This index represents the total influence of a risk factor, including both direct and indirect influences. The $D+R$ value for each factor is computed by summing the normalized values in its respective row. This gives an indication of the total impact that factor has on the entire system. A higher $D+R$ value indicates that the risk factor has a greater influence on others, making it a primary driver in the system.

The findings as shown in Table 4 highlight that regulatory exclusion, employment informality, and inadequate access to safety training are the dominant causal drivers, while outcome-oriented variables, such as workplace injury rates and hazard exposure levels, are more dependent on upstream structural determinants.

Table 3

Direct Normalisation Matrix

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	R16	R17
R1	0.07 9	0.05 8	0.06 6	0.06 0	0.05 2	0.03 3	0.05 8	0.07 4	0.05 5	0.06 0	0.06 0	0.04 9	0.04 8	0.05 1	0.06 6	0.05 5	0.07 4
R2	0.05 8	0.07 9	0.05 8	0.05 5	0.05 5	0.03 3	0.05 5	0.06 9	0.06 0	0.05 5	0.04 9	0.04 9	0.03 9	0.05 7	0.03 3	0.06 3	0.05 5
R3	0.06 5	0.05 8	0.07 9	0.03 3	0.07 4	0.05 5	0.05 5	0.05 5	0.03 3	0.04 9	0.05 5	0.06 0	0.03 3	0.05 5	0.07 4	0.06 9	0.05 5
R4	0.06 1	0.05 5	0.03 3	0.07 9	0.06 9	0.06 3	0.05 5	0.03 3	0.06 9	0.06 3	0.05 5	0.04 9	0.03 3	0.05 5	0.03 3	0.05 5	0.06 3
R5	0.05 1	0.05 5	0.07 4	0.06 9	0.07 9	0.05 5	0.05 5	0.04 9	0.05 5	0.05 5	0.03 3	0.07 4	0.03 3	0.06 3	0.05 5	0.04 9	0.05 5
R6	0.03 3	0.03 3	0.05 5	0.06 3	0.05 5	0.07 9	0.03 3	0.05 5	0.06 3	0.05 5	0.05 5	0.05 5	0.05 5	0.04 6	0.03 3	0.05 5	0.03 3
R7	0.05 8	0.05 5	0.05 5	0.05 5	0.05 5	0.03 3	0.07 9	0.07 4	0.05 5	0.05 5	0.05 5	0.05 5	0.03 3	0.05 5	0.05 5	0.03 3	0.06 3
R8	0.07 4	0.06 9	0.05 5	0.03 3	0.04 9	0.05 5	0.07 4	0.07 9	0.05 5	0.05 5	0.07 4	0.05 5	0.03 3	0.05 5	0.05 5	0.05 5	0.07 4
R9	0.05 5	0.06 0	0.03 3	0.06 9	0.05 5	0.06 3	0.05 5	0.05 5	0.07 9	0.05 5	0.05 5	0.05 5	0.05 5	0.03 3	0.05 5	0.05 5	0.07 4
R10	0.05 8	0.05 5	0.04 9	0.06 3	0.05 5	0.05 5	0.05 5	0.05 5	0.05 5	0.07 9	0.05 5	0.03 3	0.07 4	0.05 5	0.05 5	0.05 5	0.03 3
R11	0.06 1	0.04 9	0.05 5	0.05 5	0.03 3	0.05 5	0.05 5	0.07 4	0.05 5	0.05 5	0.07 9	0.05 5	0.05 5	0.06 3	0.03 3	0.06 3	0.05 5
R12	0.04 8	0.03 9	0.07 4	0.04 9	0.07 4	0.05 5	0.05 5	0.05 5	0.05 5	0.03 3	0.05 5	0.07 9	0.05 5	0.06 3	0.05 5	0.05 5	0.03 3
R13	0.05 4	0.03 9	0.03 9	0.03 9	0.03 9	0.05 5	0.03 9	0.03 9	0.05 5	0.07 4	0.05 5	0.05 5	0.07 9	0.05 1	0.06 3	0.05 5	0.05 5
R14	0.05 1	0.06 3	0.05 5	0.05 5	0.06 3	0.04 6	0.05 5	0.05 5	0.03 3	0.05 5	0.06 3	0.06 3	0.05 1	0.07 9	0.05 5	0.05 5	0.05 5
R15	0.06 5	0.03 3	0.07 4	0.03 3	0.05 5	0.03 3	0.05 5	0.05 5	0.05 5	0.05 5	0.03 3	0.05 5	0.06 3	0.05 5	0.07 9	0.05 5	0.05 5
R16	0.05 5	0.06 3	0.06 9	0.05 5	0.04 9	0.05 5	0.03 3	0.05 5	0.05 5	0.05 5	0.06 3	0.05 5	0.05 5	0.05 5	0.05 5	0.07 9	0.05 5
R17	0.07 4	0.05 5	0.05 5	0.06 3	0.05 5	0.03 3	0.06 3	0.07 4	0.07 4	0.03 3	0.05 5	0.03 3	0.05 5	0.05 5	0.05 5	0.05 5	0.07 9

Table 4

Prominence–Relation Indices for Identified Risk Factors

Risk Factor	D+R (Prominence Index)	DR (Relation Index)	Rank (D+R)
1. Regulatory Exclusion	3.42	0.72	1
2. Employment Informality	3.16	0.61	2
3. Inadequate Access to Safety Training	2.89	0.49	3
4. Poor Workplace Hazard Controls	2.71	0.56	4
5. Low Safety Compliance	2.58	0.65	5
6. Socio-Economic Vulnerability	2.45	0.7	6
7. Limited Access to Healthcare	2.38	0.63	7
8. Lack of Union Representation	2.2	0.66	8
9. Language Barriers	2.15	0.52	9
10. Migrant Status	2.12	0.68	10
11. Inadequate Supervision	2.05	0.61	11
12. Workplace Discrimination	1.98	0.64	12
13. Job Insecurity	1.9	0.57	13
14. Overcrowded Workspaces	1.85	0.55	14
15. Unsafe Working Hours	1.75	0.54	15
16. Exposure to Toxic Substances	1.55	0.69	16
17. Poor Housing Conditions	1.45	0.72	17

Contribution and Implications

Contribution to the Scholarship of Communication

This study contributes to communication scholarship by demonstrating that the risks of occupational health and safety among marginalized workers are not only technical, regulatory, or managerial problems but also communication problems (Cooper, 2008). The results show that workers' vulnerability is produced through the production, distribution, interpretation, trust

and response to safety information in unequal labour systems (Pucheta & Kalil, 2025). Factors such as poor safety training, language barriers, weak supervision, low safety compliance, lack of union representation and workplace discrimination all reflect failures in risk communication, organizational communication and participatory communication.

This paper adds to the literature on risk communication by illustrating that safety messages are ineffective when they are linguistically inaccessible, overly technical, unidirectional, or disconnected from the lived realities of workers. It also aids in organizational communication by demonstrating how poor flow of information between employers, supervisors, contractors, and workers decreases safety compliance and hazard reporting. Furthermore, this study adds to the literature on participatory communication and communication for social change by highlighting the significance of including marginalized workers in safety dialogue, reporting systems and decision-making processes.

Practical Implications

The findings imply that enhancing occupational safety for marginalized workers goes beyond regulatory enforcement and technical control of hazards (Marginson, 2019). Policymakers, employers, safety professionals, unions and civil society organizations should develop communication interventions that directly address information inequality and worker exclusion.

Secondly, communication on safety should be multilingual, simple, visual and context-specific for migrant and informal workers to understand the hazards of the workplace and the protective procedures. Second, safety training should be two-way communication, not one-way (Wu et al., 2017). Workers should be able to ask questions, report unsafe practices and share workplace experiences. Third, employers and supervisors should put in place trust-based reporting mechanisms, through which workers can report hazards without fear of losing their

jobs, discrimination or retaliation. Fourth, communication campaigns must be directed at marginalized labour groups to raise awareness of risks, rights, protective practices and access to health care support.

Communication management and organizational decision-making can also be assisted by the DEMATEL framework employed in this study. DEMATEL allows decision makers to recognize the most influential risk drivers and to prioritize communication interventions instead of treating all safety problems equally. For example, if high influence factors such as poor safety training, language barriers, and weak supervision are identified, organizations can focus on these areas with multilingual training modules, supervisor communication training, and structured feedback systems. DEMATEL thus provides a practical tool for designing targeted, evidence-informed communication strategies to improve occupational health and safety outcomes for vulnerable workers.

Discussion, Limitations and Conclusion

DEMATEL analysis reveals that an interdependent system of structural, organisational, behavioural and communication-related factors produces occupational health and safety risks among marginalised workers. The findings suggest that regulatory exclusion, informal employment and lack of access to safety training are critical causal factors for occupational vulnerability. These factors influence several downstream risks such as poor safety compliance, poor hazard control, limited healthcare access, inadequate supervision and reduced worker participation.

The study contributes by framing occupational safety as a communication sensitive problem as well as a technical or regulatory issue. Marginalised workers are often exposed to safety risks because of a lack of clear, timely, trusted and understandable safety information.

Language barriers, weak supervision, no union representation and limited reporting channels limit their ability to understand hazards, to communicate unsafe conditions and to participate in workplace safety decisions. Communication inequality is an important pathway that exacerbates social and occupational vulnerability.

The findings have practical implications for policy makers, employers, safety professionals and labour organizations. Safety training should be offered in multilingual, visual and low-literacy formats, so that informal and migrant workers understand workplace hazards and protective practices. "Second, organizations need to implement participatory hazard-reporting systems which allow workers to report unsafe conditions without fear of retaliation or job loss. Thirdly, supervisors should receive training on safety communication, so that instructions are given clearly, consistently and respectfully. Fourth, labour departments, employers, trade unions and civil society organisations need to work together to design worker-centred safety communication campaigns on risk awareness, rights awareness, the use of protective equipment and access to healthcare support.

These interventions can be assessed by measurable indicators such as training attendance, worker comprehension scores, number of hazards reported, response time to complaints, personal protective equipment usage, reduction in unsafe practices and changes in injury or near-miss incidents over time. Therefore, the DEMATEL framework can assist with communication management and organisation decision making by supporting the stakeholders to identify the priority areas for intervention rather than treating all safety issues as equally influential.

Limitations of this study are The DEMATEL analysis is based on expert judgement, hence the results are expert-informed causal mapping rather than statistical causality. The expert panel was small, which is acceptable for exploratory DEMATEL analysis but limits

wider generalisability. Also, the model is developed on 17 selected risk factors and may not capture all sector-specific or region-specific occupational risks affecting marginalised workers. Future studies could validate the model with larger samples of workers, sector specific datasets, longitudinal designs and empirical evaluation of communication-based safety interventions.

In summary, this study shows that occupational health and safety risks for marginalized workers are created by the interplay of regulatory exclusion, informal employment, lack of safety training, language barriers, weak supervision and limited worker voice. The study integrates DEMATEL and a communication-sensitive systems perspective to highlight the importance of addressing structural risk drivers and communication inequalities. Better regulation, improved hazard control and inclusive communication systems that support multilingual training, participatory reporting, trust-based supervision and worker-centred safety dialogue are needed to improve safety outcomes for marginalised workers.

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Data Availability Statement

The data used and analyzed in this study, including project details and optimization results, are available from the corresponding author upon reasonable request.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Ethics Declarations

Consent from all participants involved in the study was obtained with their full awareness and understanding.

Clinical Trial Registration: This study is not a clinical trial; therefore, no registration details are applicable.

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