

ASSESSMENT OF OCCUPATIONAL SAFETY PRACTICES IN ROAD CONSTRUCTION PROJECTS: ANALYSIS OF SAFETY CHALLENGES, CAUSAL FACTORS, AND MITIGATION STRATEGIES IN THE SHELLEGHAT–RAMECHHAP–SANGUTAR ROAD PROJECT, NEPAL

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ABSTRACT

This study critically evaluates occupational safety practices at the Shelleghat–Ramechhap–Sangutar Road Project in Ramechhap District, Nepal, assessing existing safety measures, their implementation, and the challenges encountered in maintaining a secure work environment on a road project constructed largely on steep, slope-prone terrain. A mixed-method research design was employed, integrating a structured questionnaire survey of 155 respondents (contractors, consultants, clients, social activists and others) with qualitative in-depth interviews, focus group discussions, and field observations. Quantitative data were analyzed using descriptive statistics and the Relative Importance Index (RII). The findings revealed significant deficiencies in safety management. “Inadequate Safety Training” was ranked as the most severe problem affecting occupational safety practice (RII = 0.90), followed by shortage of safety equipment (RII = 0.88) and low safety awareness (RII = 0.87). Many workers lacked access to proper personal protective equipment (PPE), and enforcement of safety guidelines remained inconsistent. Although basic signage and first-aid facilities were in place, regular safety audits, comprehensive training, and systematic equipment maintenance were often neglected. Causal analysis of nineteen major safety issues showed that inadequate training programs, high training costs, budget constraints, and weak supervision were the dominant underlying causes, while increased accident risk, higher insurance costs, and project delays were the most significant effects. The study identifies “Implement comprehensive and mandatory safety training programs for all workers” as the highest-ranked mitigation measure (RII = 0.89), followed by the provision of sufficient PPE and continuous safety-awareness campaigns. The findings underscore the urgent need for policy reform, stakeholder collaboration, and sustained investment in occupational safety to improve working conditions in Nepal's road construction sector, particularly in geographically challenging rural terrain.

Keywords: Occupational safety, Road Construction, Safety protocols, Personal Protective Equipment (PPE), Safety Standards, Safety Audit

1. INTRODUCTION

Occupational safety and health (OSH) is broadly defined as the science of anticipation, recognition, evaluation, and control of hazards arising in or from the workplace that could impair the health and wellbeing of workers, taking into account the possible impact on surrounding communities and the environment. Construction projects consistently record among the highest frequencies of occupational accidents compared with other industries, and the main causes are largely attributable to poor safety management and a lack of worker safety awareness [1], [2].

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Nepal's road construction sector is notorious for hazardous working conditions, as workers are exposed to serious health and safety risks throughout construction, maintenance, and operation. These risks include long-term health problems arising from exposure to hazardous materials and unsafe working conditions, as well as physical injuries from falls and accidents. Even though these concerns are becoming more widely acknowledged, road construction sites in Nepal have not adequately adopted health and safety procedures, largely because of inadequate resources, the absence of unified organizational policy, and lax enforcement of safety regulations [1].

According to estimates of the International Labour Organization, work-related accidents claim the lives of approximately 2.3 million people worldwide every year, with a further 313 million non-fatal accidents and over 160 million people affected by occupational and work-related illness annually; occupational accidents and disorders are estimated to cost the global economy roughly 4% of annual GDP [3]. Road construction in Nepal is characterised by a high accident rate, and workers face particular difficulties, including exposure to hazardous equipment, severe weather, and unstable terrain, all of which elevate the risk of accidents [1].

The Shelleghat–Ramechhap–Sangutar Road Project is constructed largely across steep, slope-prone terrain, making the site especially prone to accidents. Despite this high-risk environment, the attention given to preventive and protective measures remains inadequate: while personal protective equipment is used on site, its implementation is inconsistent, safety barriers and warning tapes around excavated areas are often absent, and traffic-safety measures for construction vehicles remain insufficient. This study assesses occupational safety practices on the project, identifies the principal problems, causes, and effects of safety deficiencies, and proposes practical mitigation measures to improve safety management on rural road construction projects in Nepal.

The specific objectives of this study are: (a) to identify the key problems related to occupational safety practices at the Shelleghat–Ramechhap Sangutar Road Project; (b) to analyze the causes and effects of the occupational safety issues identified at the project site; and (c) to explore effective mitigation measures for improving occupational safety practice.

2. MATERIALS AND METHODS

2.1 Study Area

The study was carried out on the Shelleghat–Ramechhap–Sangutar Road Project (Chainage 0+000 to 49+817), an upgrading and improvement of a 49.817 km road in Ramechhap District, Bagmati Province, Nepal, passing through Ramechhap Bazaar, Chhap, Sukajor, Simle, Salupati, Deurali, Mahatgau, Tallabesi, Thakle, and Sangutar. The project, funded through the Export-Import Bank of India, involves a formation width of 9 m, a carriageway width of 7 m, a design speed of 40 km/hr, and a double bituminous surface treatment (DBST) surface throughout its length. The study area was selected to assess public and stakeholder perception of occupational safety practice on a road project constructed largely across steep and geologically challenging terrain.

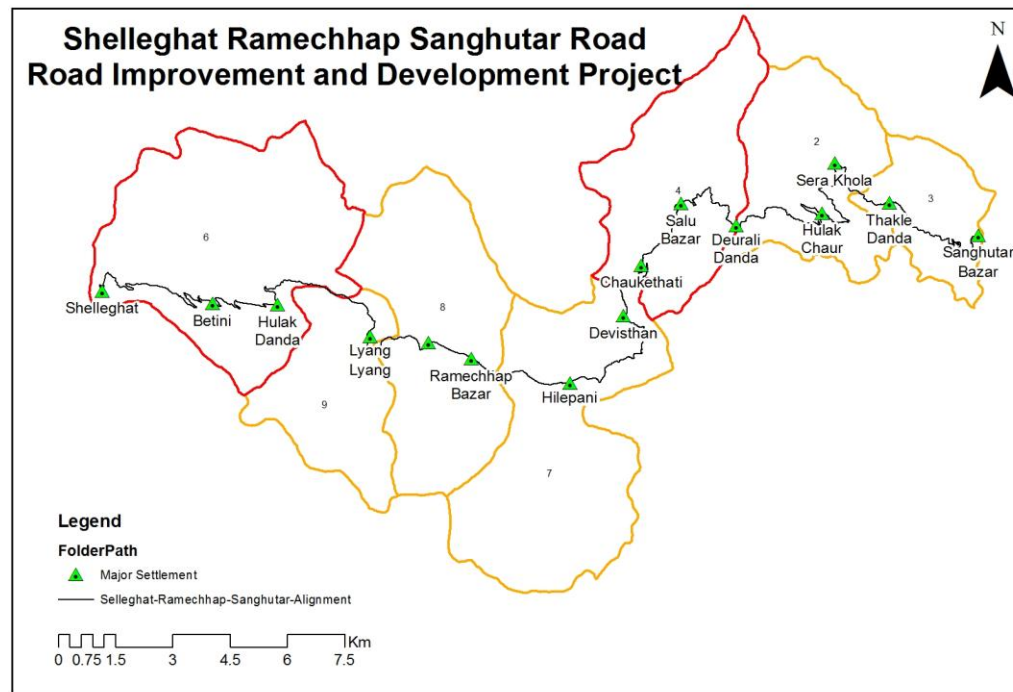


Fig. 2.1. Map of the study area, Shelleghat–Ramechhap–Sanghutar Road Project (Source: DPR Report)

2.2 Research Design

A mixed-method research approach combining quantitative and qualitative techniques was adopted, integrating a structured questionnaire survey with field observations, in-depth interviews (IDI), and focus group discussions (FGD). The total population of contractor, consultant, client, social activist, and other stakeholder personnel associated with the project was estimated at $N = 678$. The sample size was determined using Slovin's formula:

$$n = N / [1 + N(e)^2] \quad (\text{Equation 1})$$

where N is the population size (678) and e is the desired level of precision (7%), giving a required sample size of $n \approx 155$. Purposive and convenient sampling was used during field investigation, and a total of 155 valid responses were analyzed.

Data analysis

Data were analyzed primarily through the Relative Importance Index (RII), used to rank the problems, causes, effects, and mitigation measures associated with occupational safety identified through the questionnaire survey. Respondents rated each item on a five-point scale (Strongly Disagree = 1 to Strongly Agree = 5), and RII was computed as:

$$RII = \Sigma W / (A \times N) = (5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1) / 5N \quad (\text{Equation 2})$$

where W is the weight assigned by each respondent (1–5), A is the highest weight (5), N is the total number of respondents, and n_1 – n_5 are the numbers of respondents selecting each rating category. Higher RII values indicate items of greater relative importance.'

3. RESULTS AND DISCUSSION

3.1 Characteristics of Respondents

Among the 155 respondents, 68.4% were male and 31.6% were female (Fig. 3.1). By age, 7.1% were below 20 years, 22.6% were between 20–30 years, 30.0% were between 30–40 years, 31.3% were between 40–50 years, and 9.3% were between 50–60 years (Fig. 3.2). By profession, contractors formed the largest group (51.6%), followed by others (25.8%), with consultants and social activists each accounting for 9.7% and clients 3.2% (Fig. 3.3). By education, 43.2% of respondents held a Bachelor's degree, 27.1% had completed Intermediate/+2 level, 14.2% had basic education, 13.6% held a Master's degree, and 1.9% held a PhD (Fig. 3.4).

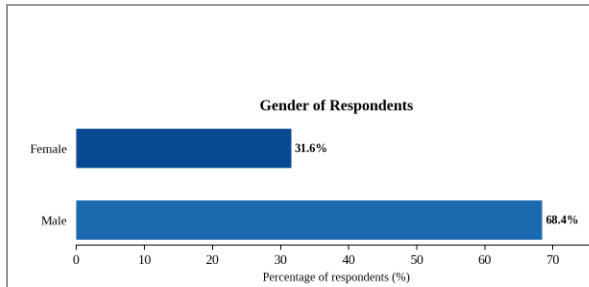


Fig. 3.1. Gender of Respondent

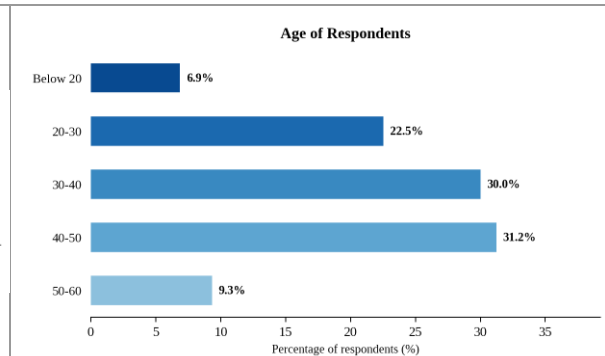


Fig. 3.2. Age of Respondents

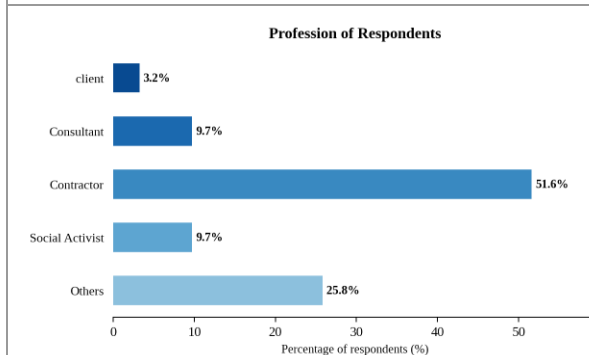


Fig. 3.3. Profession of Respondents

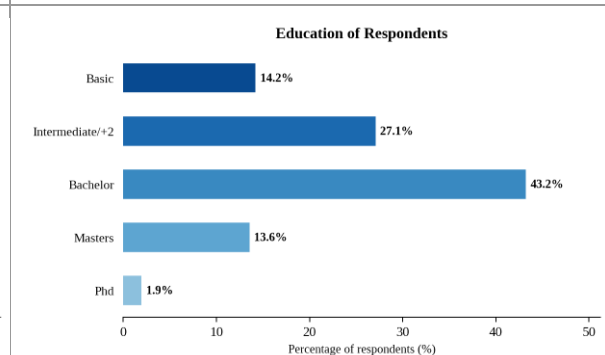


Fig. 3.4. Education of Respondents

3.2 Major Problems of Occupational Safety Practice

Relative Importance Index analysis was applied to nineteen problem statements to identify the most significant issues affecting occupational safety practice on the project. “Inadequate Safety Training” received the highest rank (RII = 0.90), followed by “Shortage of Safety Equipment” (RII = 0.88) and “Low Safety Awareness” (RII = 0.87). “No Safety Culture” received the lowest rank (RII = 0.59), as shown in Fig. 3.5.

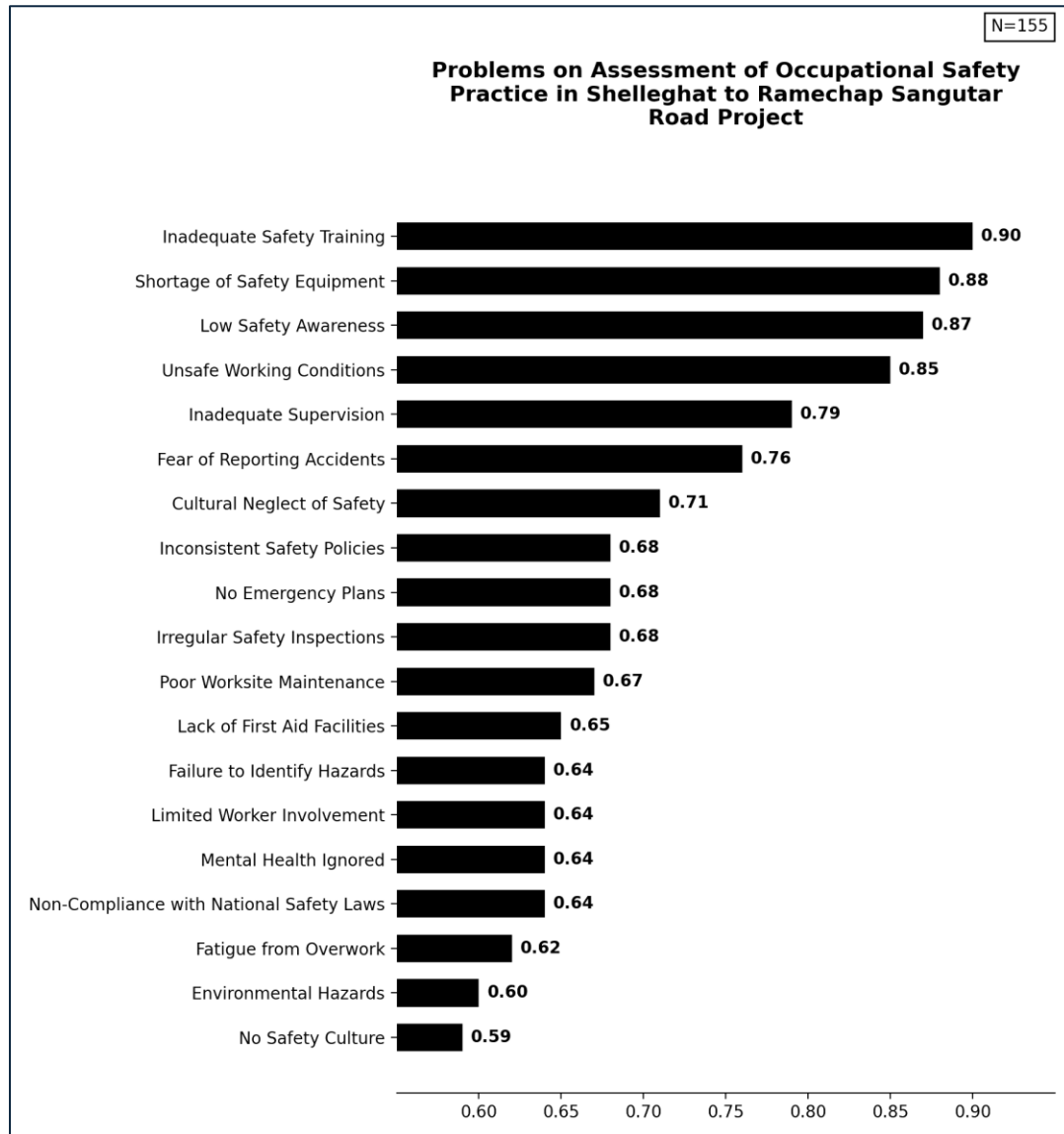


Fig. 3.5. Problems of occupational safety practice in the Shelleghat–Ramechhap–Sangutar Road Project
(Source: Field Survey, 2024)

3.3 Analysis of Causes and Effects of Occupational Safety Issues

For each of the nineteen problem areas identified in Section 3.2, the underlying causes and resulting effects were separately analyzed using RII, based on the weighted responses of the 155 survey participants. The ranked causes and effects for each issue, from Inadequate Safety Training through to No Safety Culture, are presented in Figs 3.6 through 3.43.



Fig. 3.6(a) Causes and Effects of Inadequate of Safety Training

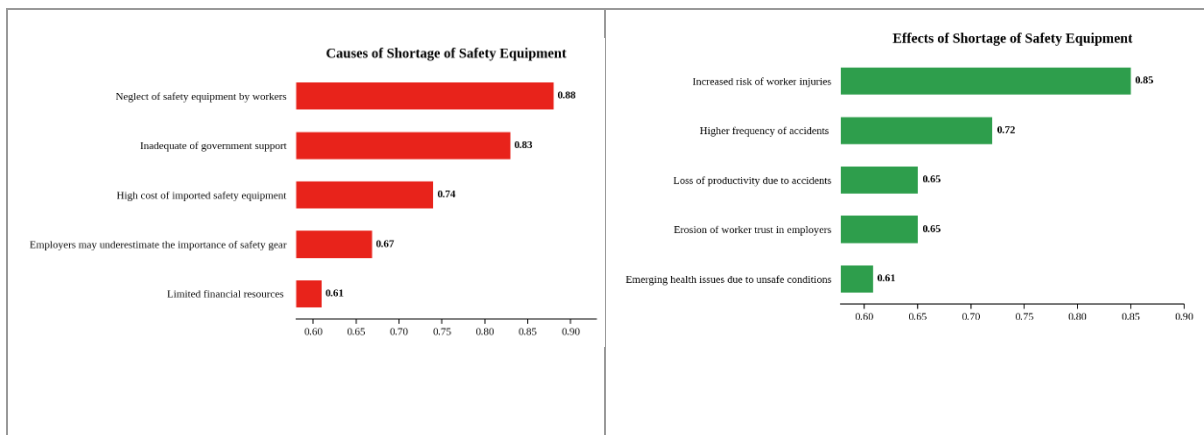


Fig. 3.6(b) Causes and Effects of Lack of Safety Training

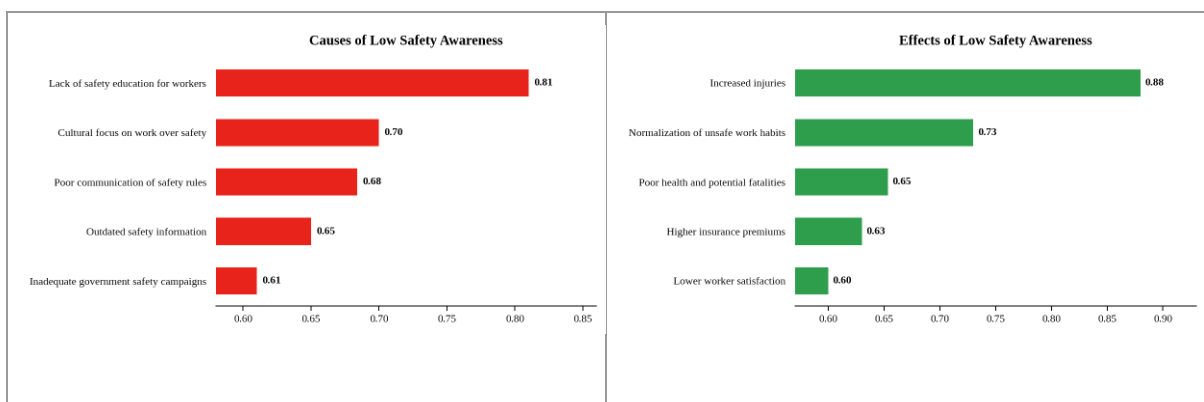


Fig. 3.6(c) Causes and Effects of Lack of Safety Awareness

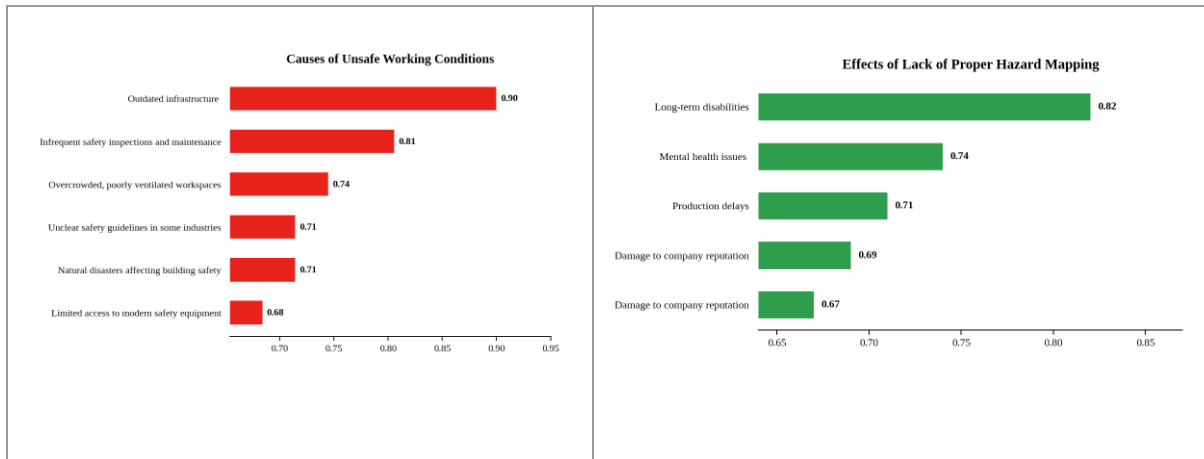


Fig. 3.6(d) Causes and Effects of Lack of Proper Hazard Mapping

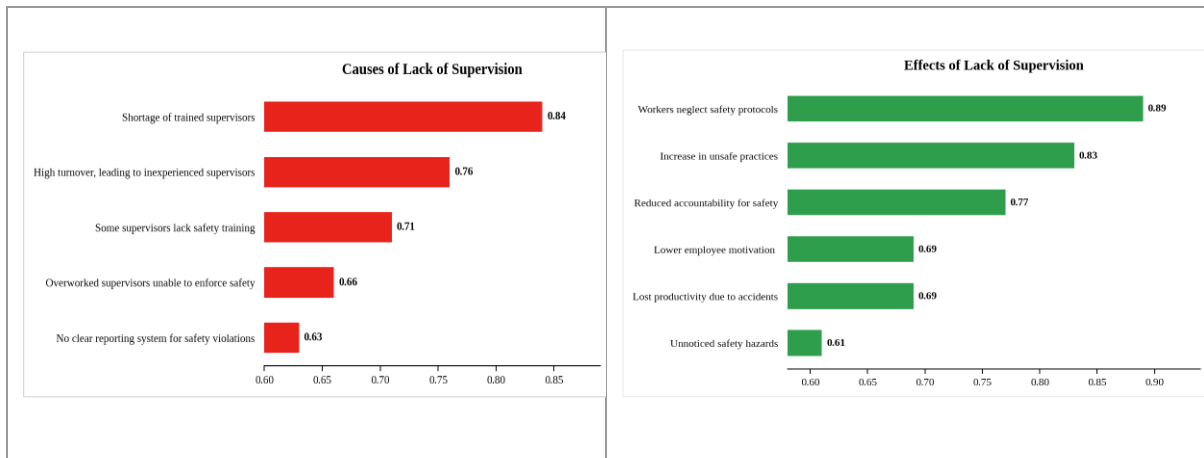


Fig. 3.6(e) Causes and Effects of Supervision

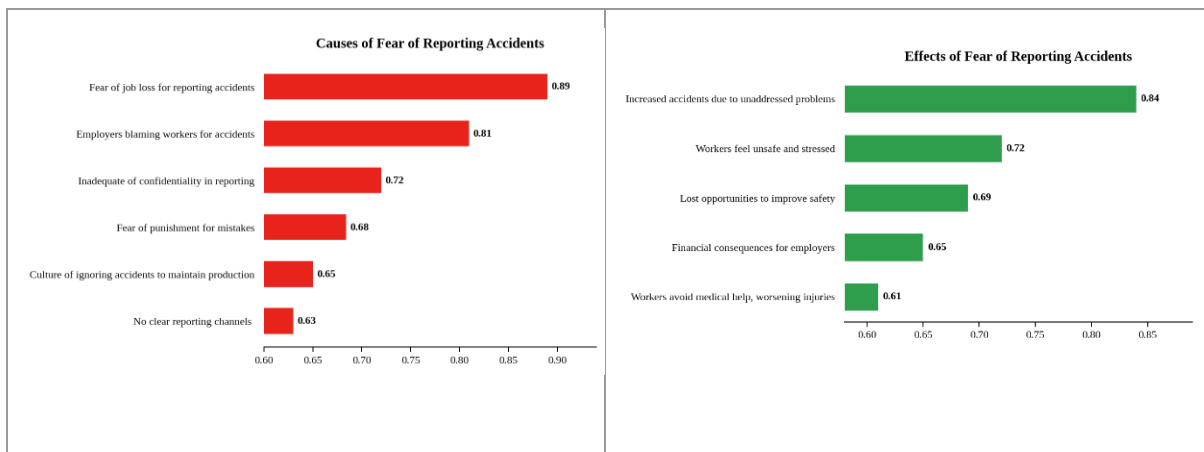


Fig. 3.6(f) Causes and Effects of Fear of Reporting Accidents

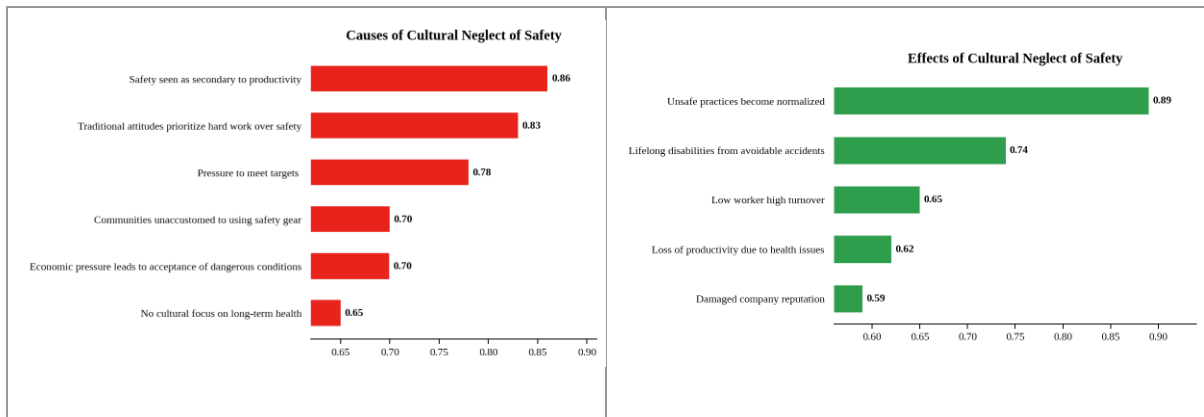


Fig. 3.6(g) Causes and Effects of Cultural Neglect of Safety

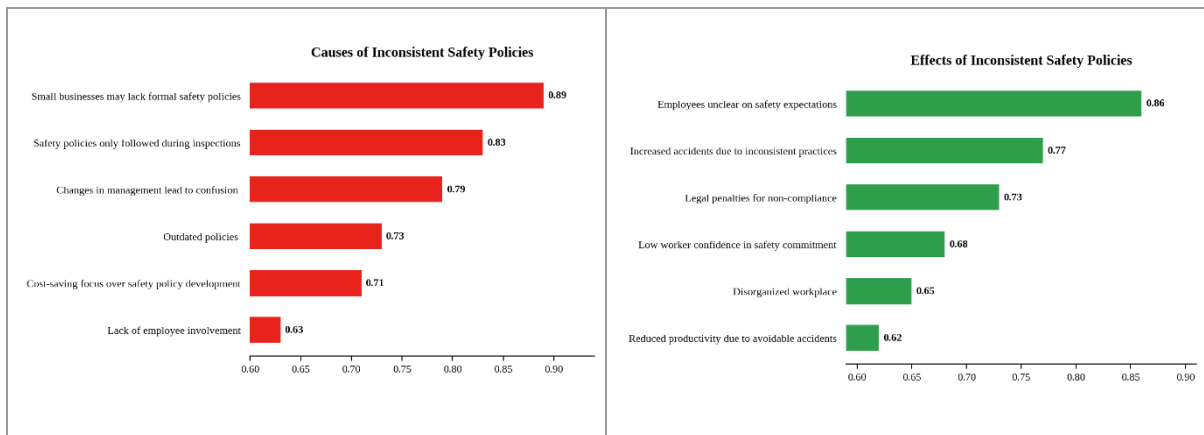


Fig. 3.6(h) Causes and Effects of Fear of Inconsistent Safety Policies

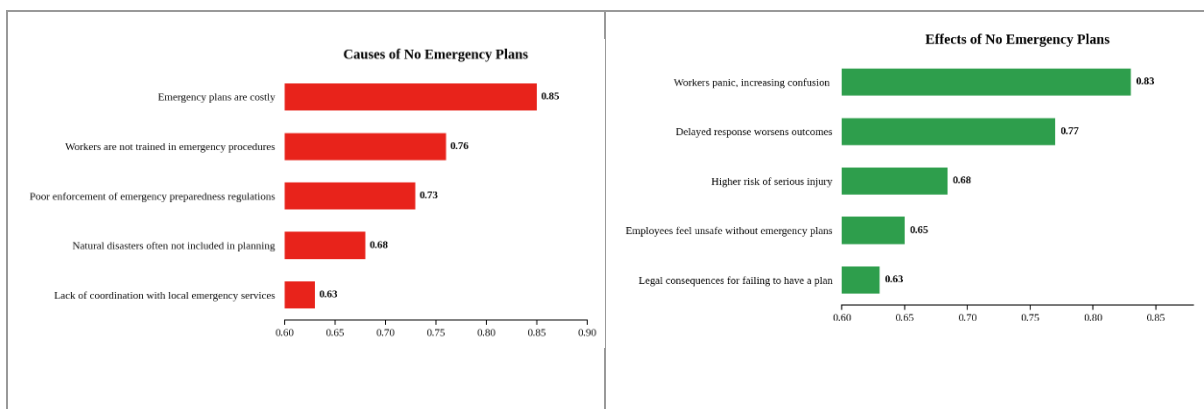


Fig. 3.6(i) Causes and Effects of No Emergency Plans

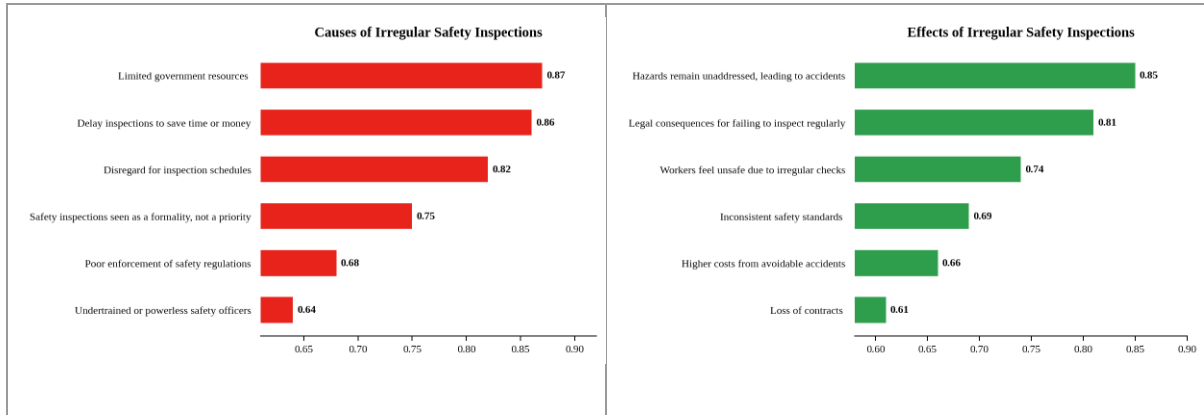


Fig. 3.6(j) Causes and Effects of Fear of Irregular Safety Inspections

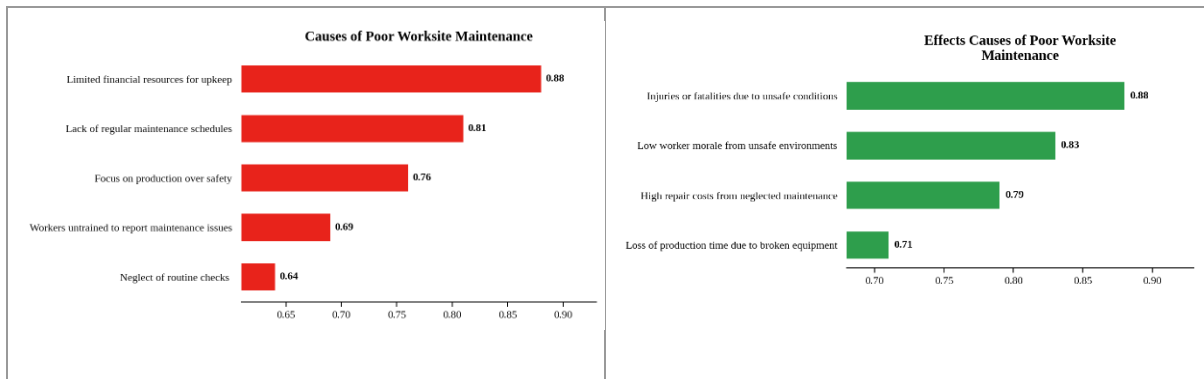


Fig. 3.6(k) Causes and Effects of Poor Worksite Maintenance

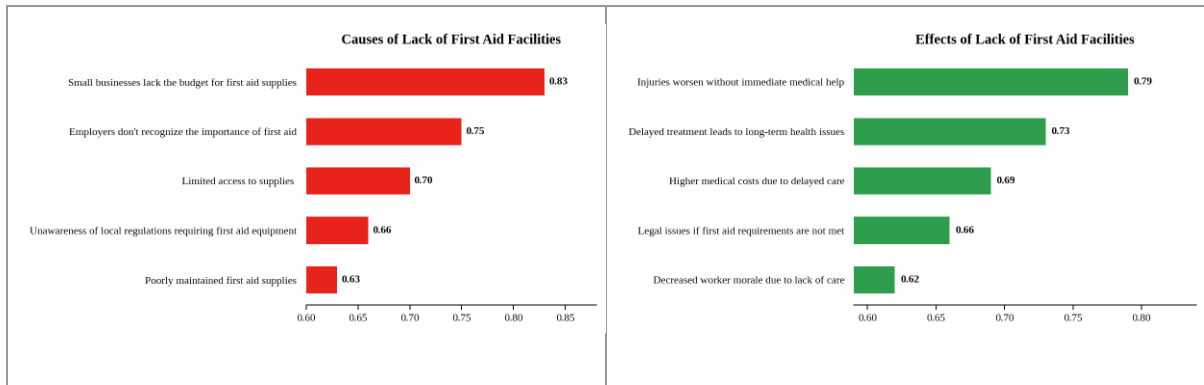


Fig. 3.6(l) Causes and Effects of Lack of First Aid Facilities

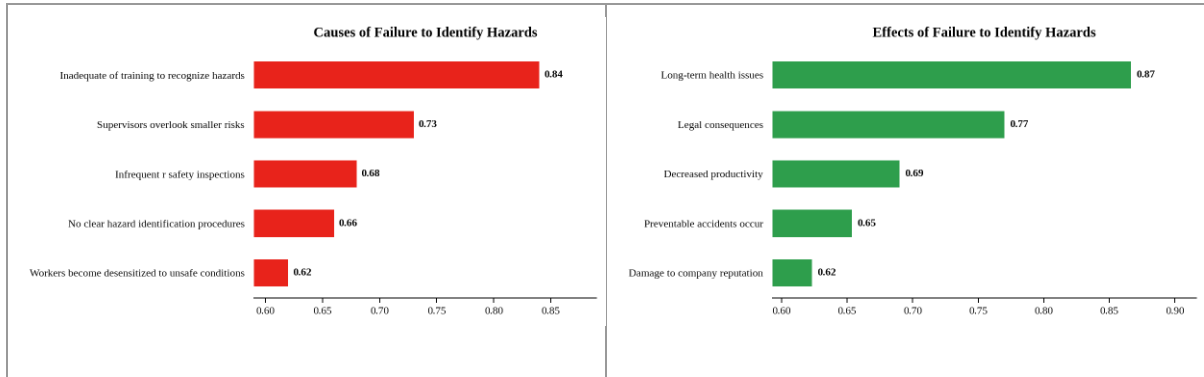


Fig. 3.6 (m) Causes and Effects of Failure to Identify Hazards

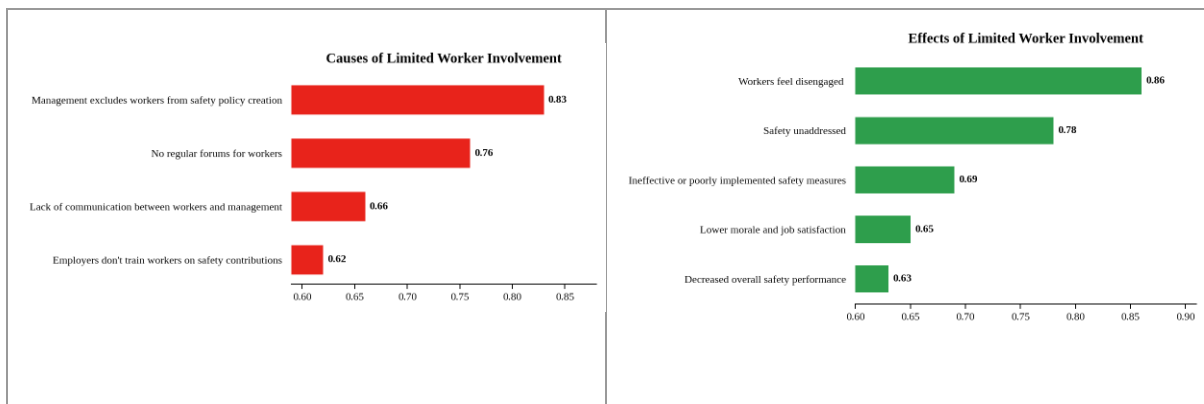


Fig. 3.6(n) Causes and Effects of Limited Worker Involvement

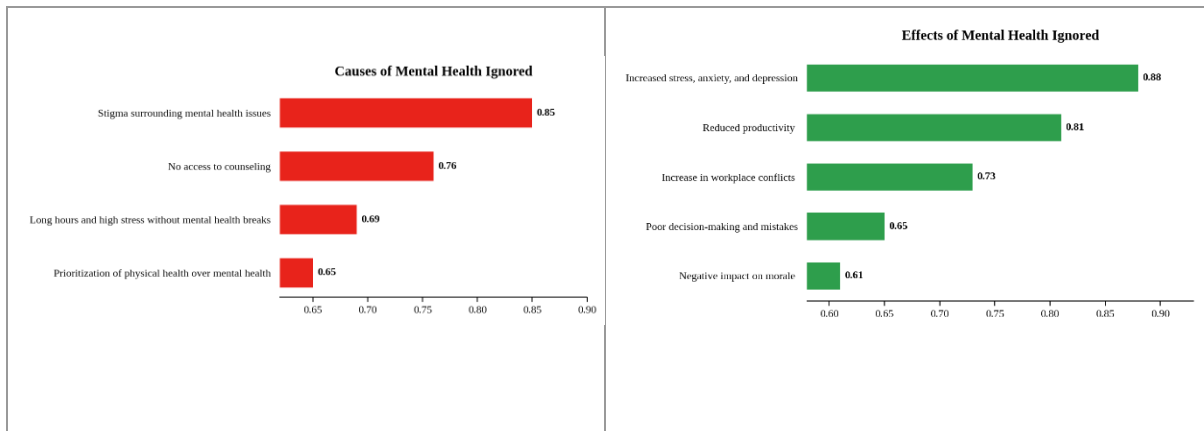


Fig. 3.6(o) Causes and Effects of Mental Health Ignored

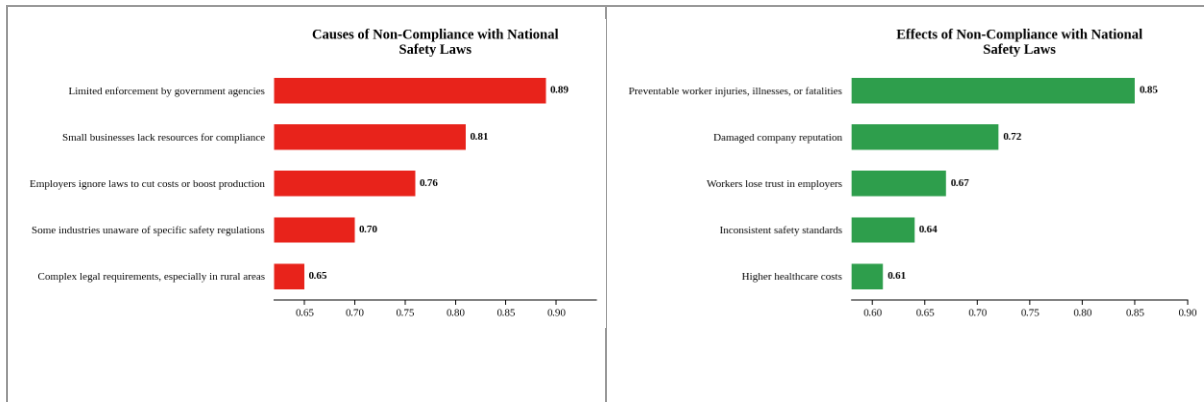


Fig. 3.6(p) Causes and Effects Non Compliance With National Safety Laws

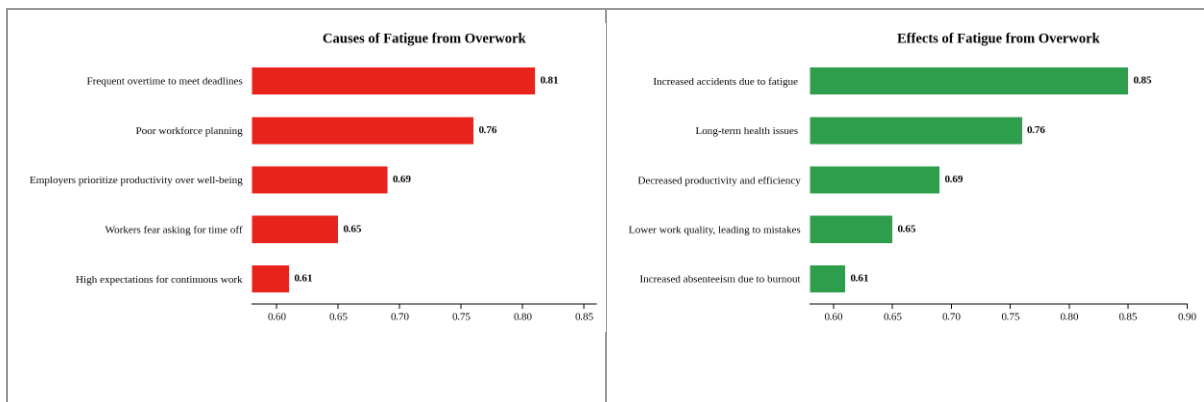


Fig. 3.6 (q) Effects of Environmental Hazards

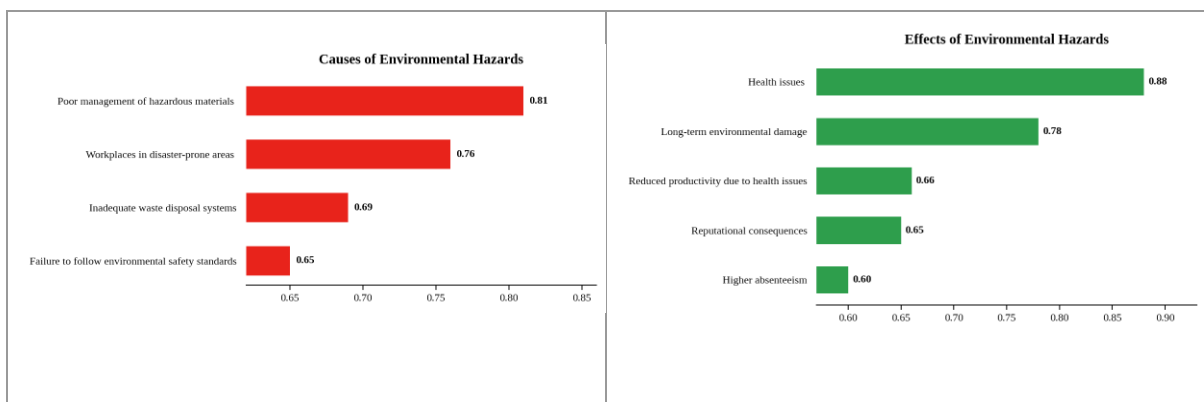


Fig. 3.6 (r) Causes and Effects of Environmental Hazards

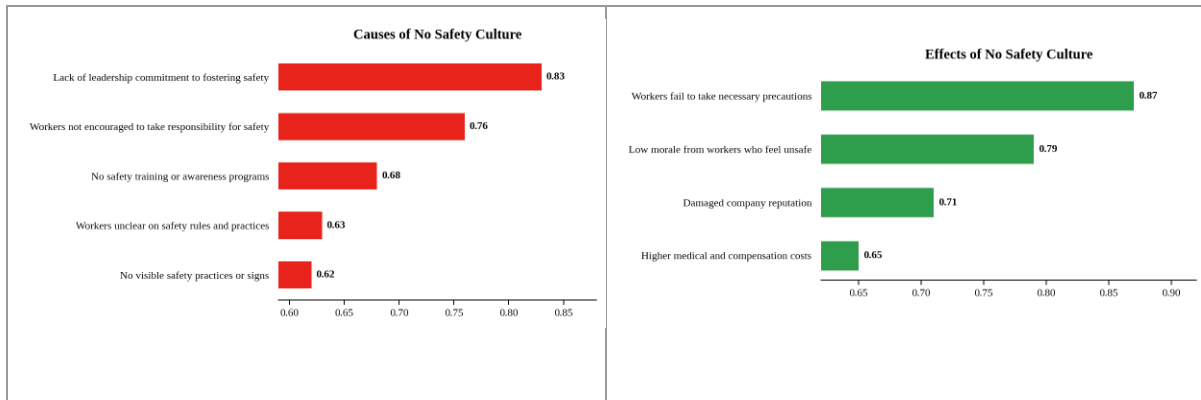


Fig. 3.6(s). Causes and Effects of No Safety Culture

3.4 Mitigation Measures

An integrated set of nineteen mitigation measures was evaluated through RII to identify the most effective strategies for improving occupational safety practice. “Implement comprehensive and mandatory safety training programs for all workers” received the highest rank (RII = 0.89), followed by “Provide sufficient PPE for all workers” (RII = 0.87) and “Launch continuous safety awareness campaigns” (RII = 0.85). “Ensure management commitment to safety practices at every stage of the project” received the lowest rank (RII = 0.59), as shown in Fig. 3.44.

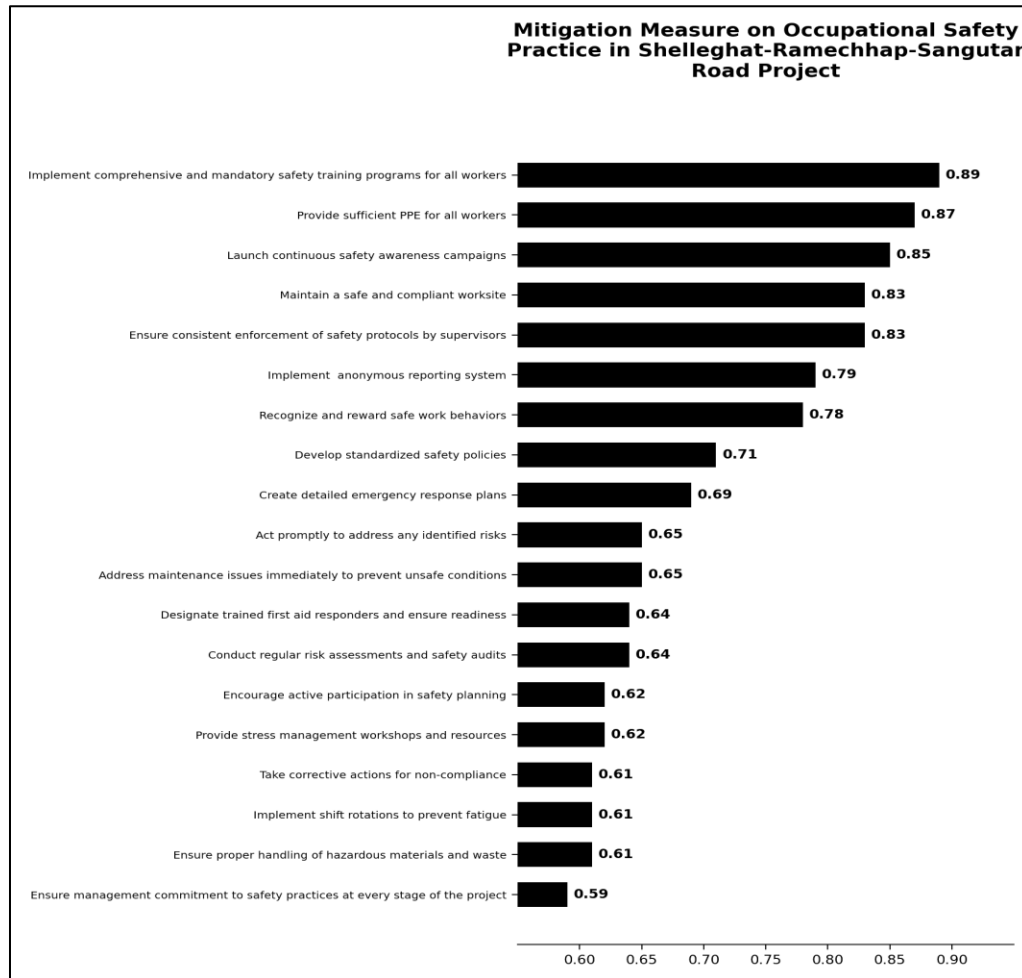


Fig. 3.7. Mitigation measures for occupational safety practice in the Shelleghat–Ramechhap–Sangutar Road Project (Source: Field Survey, 2024)

3.5 Discussion

In-depth interviews and focus group discussions with workers, supervisors, and stakeholders reinforced the quantitative findings. Workers frequently reported insufficient access to personal protective equipment such as helmets, gloves, and safety harnesses, and highlighted that the steep terrain and frequent landslides along the alignment posed severe hazards that were not matched by consistent safety measures. Supervisors acknowledged these gaps but attributed them to budgetary limitations and the logistical difficulty of transporting safety resources to a remote, rural site. Field observations corroborated these accounts: workers were frequently seen operating machinery and undertaking manual excavation without adequate PPE, safety signage and barriers around hazardous zones were inadequately maintained, and emergency response provisions such as first-aid kits and evacuation routes were poorly organized. Across all three qualitative methods, the absence of a dedicated on-site safety officer and the lack of regular safety audits emerged as a recurring systemic gap, pointing to a reactive rather than proactive approach to safety management.

These findings are broadly consistent with previous research on construction safety. The finding that inadequate safety training was the dominant problem is consistent with earlier work showing that a shortage of trained personnel and weak enforcement of safety standards substantially elevate accident risk on construction sites in developing countries [4], [5]. Similarly, the identification of comprehensive and mandatory training as the leading

mitigation measure aligns with evidence that safety training is most effective for reducing incidents when it is reinforced by management commitment, adequate resourcing, and consistent supervision, rather than delivered as an isolated intervention [6].

The predominance of inadequate training, equipment shortages, and low awareness identified in this study mirrors patterns reported in other South Asian and Nepalese road and building construction projects, where limited institutional capacity, weak regulatory enforcement, and constrained project budgets consistently undermine occupational safety outcomes [7], [8], [9]. This consistency suggests that the safety deficiencies observed at Shelleghat–Ramechhap–Sangutar are not unique to this project but reflect broader structural challenges facing Nepal's rural road construction sector, reinforcing the case for stronger regulatory oversight, mandatory safety-training requirements, and greater stakeholder accountability across similar projects [10], [11], [12].

4. CONCLUSIONS

This study has assessed occupational safety practices at the Shelleghat–Ramechhap–Sangutar Road Project, Nepal, using a mixed-method design combining a 155-respondent RII-based questionnaire survey with qualitative interviews, focus group discussions, and field observations. The assessment identified critical shortcomings in current safety management, with inadequate safety training, insufficient safety equipment, and low safety awareness ranked as the most significant problems undermining a safe working environment. Causal analysis across nineteen safety issues showed that these problems stem largely from insufficient prioritization of safety in project planning, limited resources allocated to safety measures, and weak enforcement of safety standards — deficiencies that translate into a heightened risk of accidents, injuries, project delays, and cost overruns.

The study has found that comprehensive and mandatory safety training programs, the consistent provision of personal protective equipment, and continuous safety-awareness campaigns are the most effective mitigation measures available to project management. Implementing these measures alongside regular safety audits, clearer emergency response planning, and stronger accountability among contractors and supervisors would substantially improve safety outcomes on this and comparable rural road construction projects. The findings reinforce the need for policy reform, sustained investment in occupational safety, and closer stakeholder collaboration to protect workers and support the efficient, sustainable delivery of road infrastructure in Nepal's geographically challenging terrain.

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