

Examining the Shortage of Skilled Labor in Selected Building Construction Projects within Kathmandu Valley

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Abstract

The construction industry in Nepal faces a critical shortage of skilled labor, which adversely affects project delivery, quality, and cost. This study examines the causes, effects, and mitigation strategies associated with skilled labor shortages in selected building construction projects within the Kathmandu Valley. Grounded in Human Capital Theory and Labor Market Theory, a mixed-methods approach was adopted, combining a structured questionnaire survey of 101 respondents across ten large-scale building projects with Key Informant Interviews involving five seasoned construction professionals. Principal Component Analysis identified five principal cause components Personal Factors, Developmental Factors, Workplace Factors, Conflicts, and Employment Factors explaining 54.54% of the total variance. Similarly, four effect components Technical Issues, Health and Wealth Issues, Managerial Issues, and Firm-level Managerial Deficiencies accounted for 62.97% of the variance. The study further identified ten effective strategies through qualitative analysis, with investment in training and development ranked highest (RII = 0.84). Comparison with related studies on labor dissatisfaction and compliance in Nepalese construction reveals consistent patterns, particularly regarding delayed payment, unsafe working conditions, inadequate compensation, and gaps in Labor Act awareness. The findings provide actionable insights for policymakers and industry stakeholders.

Keywords: *Skilled labor shortage, Building construction, Kathmandu Valley, Principal Component Analysis, Relative Importance Index, Construction industry*

I. INTRODUCTION

The construction industry serves as a fundamental pillar of economic development in Nepal, generating substantial employment and contributing significantly to the national GDP. However, the sector has been increasingly constrained by a persistent shortage of skilled labor, which undermines productivity, compromises project quality, and escalates costs. The Asian Development Bank report of 2012 projected significant labor deficits across various trades, including masons, welders, electricians, and plumbers, with shortages ranging from 559 to 587 workers per trade [1]. This shortage is particularly acute in the Kathmandu Valley, where rapid urbanization, population

growth, and post-earthquake reconstruction have intensified demand for skilled workers far beyond the available supply.

Several interconnected factors contribute to this shortage. The migration of skilled workers abroad for better remuneration represents one of the most significant drivers, as remittance from foreign employment constitutes a major share of Nepal's national income. Additionally, declining interest among younger generations in construction careers, inadequate vocational training infrastructure, and poor working conditions on sites further exacerbate the problem [2]. Studies on labor dissatisfaction in Nepalese construction projects have identified delayed payment, inadequate compensation, unsafe working conditions, excessive working hours, and insufficient safety measures as persistent grievances that drive skilled workers away from domestic projects [14]. Research on labor compliance in Kathmandu's construction sector further reveals that while workers have high awareness of certain rights under the Labor Act, significant gaps exist regarding remuneration, transportation arrangements, and timely wage payment [15]. These dissatisfaction and compliance gaps directly correlate with the personal, workplace, and employment factors identified in this study.

The effects are far-reaching, encompassing delays in project completion, decreased quality of workmanship, increased material wastage, elevated health and safety risks, and cost overruns that burden both public and private sector stakeholders [3]. Studies of retrofitting projects in Kathmandu Valley have documented time overruns ranging from 42% to 167%, with unavailability of skilled workforce ranking among the top three delay factors [16]. Similarly, assessments of labor conditions in Banke District have found serious issues including inadequate training programs, lack of PPE, limited health insurance coverage, and wage payment delays [17]. These findings indicate that labor-related challenges are not confined to the Kathmandu Valley but are systemic across Nepal's construction sector.

This study aims to: (1) identify the major causes of skilled labor shortage in selected construction projects within Kathmandu Valley, (2) determine the effects of such shortages on project outcomes, and (3) propose effective strategies to mitigate the labor shortage problem. By employing a mixed-methods research design combining quantitative survey data with qualitative expert insights, this research provides a holistic and empirically grounded understanding of the skilled labor shortage phenomenon in Nepal's building construction industry.

II. LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

A. Literature Review

The shortage of skilled labor in the construction industry is a global concern that has attracted considerable scholarly attention. Akomah et al. [2] identified low motivation among workers, poor treatment by employers, and lack of clear career advancement paths as key personal factors driving labor shortages in Ghana. Their findings highlighted that when workers perceive limited opportunities for professional growth,

they are more likely to migrate to other sectors or countries. Aiyetan and Dillip [4] emphasized the role of inadequate safety practices and hostile working environments in deterring skilled workers, while Tshele and Agumba [5] highlighted insufficient practical exposure during vocational training and the need for sustained investment in training and education. Nighute and Mhaske [6] documented the managerial effects of labor shortages, including difficulty in control, overstress among remaining workers, and diminished health outcomes.

In the Nepalese context, foreign employment opportunities attract skilled construction workers away from domestic projects, while the negative perception of construction careers among youth further depletes the talent pipeline [1]. Recent research has specifically examined labor dissatisfaction in Nepalese construction projects. Bista et al. [14] conducted a study of a hospital construction project in Jajarkot District and identified delayed payment, inadequate wages and compensation, unsafe working conditions, excessive working hours, and insufficient safety measures as key factors driving worker dissatisfaction and attrition. These factors are particularly relevant to the present study as they directly inform the Personal Factors and Workplace Factors components identified through PCA.

Bhattarai et al. [15] assessed compliance and welfare among construction workers in Kathmandu, surveying 31 special Labor Act provisions. Their findings revealed high worker awareness of rights regarding employer duties, non-discrimination, working hours, overtime, and safety. However, significant gaps existed in awareness regarding remuneration, transportation for female workers during unsafe hours, and timely wage payment. The study also identified challenges in labor law enforcement, including insufficient mechanisms, resource constraints, and monitoring gaps. These findings highlight that awareness of legal provisions does not necessarily translate to compliance, and gaps in worker knowledge may contribute to exploitation.

In the context of project delays, Bhattarai et al. [16] studied 11 retrofitting projects in Kathmandu Valley and found time overruns ranging from 42% to 167%. The top-ranked delay factors included impractical project schedules, unavailability of skilled workforce, lack of coherence in architectural and structural drawings, delays in shop drawing approvals, and unavailability of specific materials. The study identified skilled workforce unavailability as the second-ranked factor, demonstrating its critical role in project performance.

Bohara et al. [17] assessed labor conditions in Banke District and found that workers were largely unaware of their rights under the Labor Act, with poor working conditions including insufficient safety precautions, lack of social security, and weak labor law enforcement. Their RII analysis showed that regular toolbox talks (0.59) ranked highest among health and safety aspects, while accident rate (0.31) and adequate training programs (0.38) ranked lowest, suggesting significant room for improvement.

Elbashbishy and El-adaway [7] assessed the impact of labor shortages on project cost performance, finding that cost overruns are a direct consequence of inadequate skilled workforce availability. Kölling [11] examined restrictions in hiring workers, concluding that overly restrictive employment regulations can worsen labor shortages by limiting employer flexibility. Shiha and El-adaway [18] developed a multivariate statistical framework for assessing construction labor shortages at a localized level, demonstrating the importance of empirical quantification of shortage severity.

The concordance across these studies suggests that the labor shortage phenomenon, particularly the pull of foreign employment, youth disinterest, weak training pipelines, and enforcement gaps, is systemic across Nepal's construction sector.

B. Theoretical and Conceptual Framework

The selection of the 31 candidate causes and 24 candidate effects examined in this study was informed by two complementary theoretical lenses. Human Capital Theory conceptualizes workers' skills, training, and experience as a form of capital in which individuals and firms invest, and whose depletion through emigration, inadequate vocational training, or the absence of visible career pathways directly erodes organizational productivity [12]. Labor Market Theory frames the shortage as a persistent imbalance between the demand for skilled trades generated by rapid urbanization and post-earthquake reconstruction and a supply constrained by foreign employment outflows, youth disinterest, and restrictive hiring conditions [13]. Together, these lenses guided the screening of variables identified from the international and Nepalese literature: candidate causes were retained where they represented either an under-investment in human capital (e.g., insufficient practical exposure, no clear-cut career path) or a supply-demand distortion (e.g., growth of self-employment, restrictions in hiring workers), while candidate effects were retained where they captured the productivity and welfare consequences that both theories predict.

Recent studies on labor dissatisfaction and compliance in Nepalese construction further inform this framework. Bista et al. [14] identified delayed payment, inadequate compensation, unsafe working conditions, excessive working hours, and insufficient safety measures as primary drivers of worker dissatisfaction. Bhattarai et al. [15] found that while workers are aware of their safety-related duties, they lack awareness of entitlements such as medical insurance (7.6% awareness), accidental insurance (3.8%), and timely wage payment. These findings align closely with the Personal Factors (low motivation, poor treatment), Workplace Factors (safety issues, unfavorable environment), and Employment Factors (restrictions, self-employment) components that emerged from this study's PCA. The convergence of findings across studies validates the theoretical grounding and suggests that these issues are systematic rather than project-specific.

Figure 1 presents the resulting conceptual framework. Cause variables, grouped through PCA into five components, drive the central phenomenon of skilled labor shortage, which in turn produces effects grouped into four components. Mitigation strategies, elicited through Key Informant Interviews and ranked by the Relative Importance Index, act on the causal pathways to attenuate the shortage and its consequences. The framework recognizes that the shortage phenomenon is multi-causal and multi-dimensional, requiring interventions at multiple levels individual (training, career development), organizational (workplace safety, fair treatment), and systemic (policy, regulation)

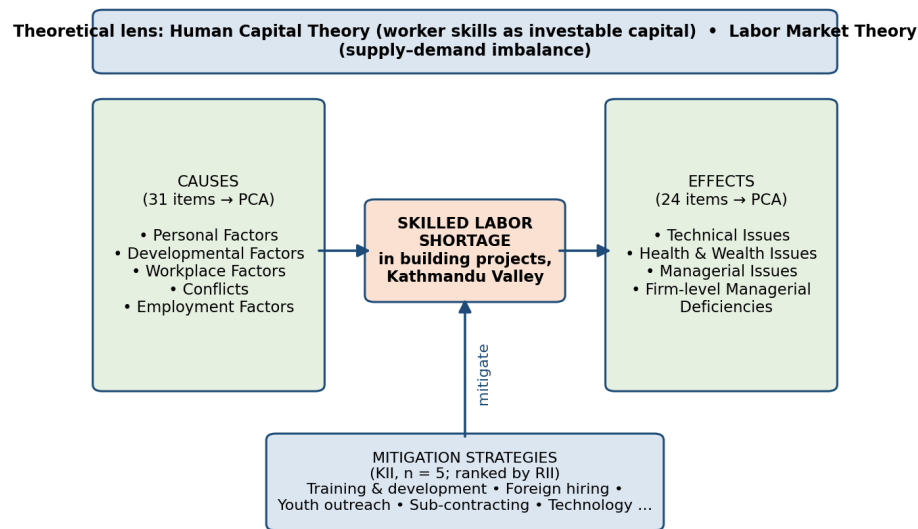


Figure 1: Conceptual framework of the study

III. RESEARCH METHODOLOGY

A. Research Design

A mixed-methods research design was employed, integrating quantitative and qualitative approaches [8]. This approach was selected because the complexity of the skilled labor shortage phenomenon requires both statistical rigor and contextual depth. The quantitative phase enabled the identification and classification of causes and effects through structured data collection and multivariate analysis, while the qualitative phase provided nuanced insights into potential strategies from experienced practitioners. The sequential explanatory design ensured that quantitative findings were further interpreted and enriched through qualitative evidence, thereby strengthening the overall validity and comprehensiveness of the research conclusions.

B. Study Area and Population

The study area encompassed the Kathmandu Valley, including the three districts of Kathmandu, Bhaktapur, and Lalitpur. This region was selected because it represents the epicenter of large-scale construction activity in Nepal, hosting the headquarters of

most major construction firms and a concentration of high-value building projects. Ten large-scale building construction projects were selected. For the purposes of this study, "large-scale" projects were operationally defined by three joint criteria: (i) assembly-type buildings located within the Kathmandu Valley, (ii) contract amounts exceeding NRs. 50 million, and (iii) execution by Grade A construction companies registered in Nepal. No additional criteria beyond these three were applied; however, preference was given to projects involving a large number of stakeholders (client, contractor, and consultant representatives) so that the sampled respondents would be representative of large-project delivery environments. The selected projects included the Federal Parliament Building Complex (NRs. 5.2 billion), Sheraton Kathmandu Hotel (NRs. 1.16 billion), Supreme Court Building Complex (NRs. 5 billion), Hotel Moxy Building Construction (NRs. 1 billion), Nepal Oil Corporation Building (NRs. 800 million), and five other significant projects. Table 1 summarizes the survey population and response rate.

Table 1: Survey population and response rate

Description	Distributed	Valid responses	Response rate (%)
Questionnaires across ten selected projects (clients, contractors, consultants)	112	101	90.17

C. Data Collection and Analysis

Primary data were collected through a structured questionnaire survey and Key Informant Interviews (KII). The questionnaire captured perceptions on 31 identified causes and 24 identified effects using a five-point Likert scale, distributed to 112 stakeholders across the ten projects with 101 valid responses (90.17% response rate). Before full deployment, a pretest study was conducted with representatives of ten contracting companies to review the wording of questions, identify ambiguities, and assess the data collection technique; in addition, two statistical experts were consulted to assess the validity of the instrument. The questionnaire was modified based on the pretest findings and expert recommendations. The KII involved five professionals, each with ten or more years of experience, comprising four client-side engineers from government agencies (including the Department of Urban Development and Building Construction and municipal/metropolitan offices) and one contractor-side project manager.

For the quantitative analysis, exploratory factor analysis was performed using principal component analysis as the extraction method, with Varimax rotation and Kaiser normalization, in SPSS. Components were retained using Kaiser's criterion (eigenvalue > 1.0), corroborated by inspection of scree plots (Figures 2 and 3). Sampling adequacy was confirmed for both variable sets: for the 31 causes, KMO =

0.824 and Bartlett's test of sphericity $\chi^2 = 1395.890$ ($df = 435$, $p < 0.001$); for the 24 effects, KMO = 0.884 and $\chi^2 = 1487.653$ ($df = 276$, $p < 0.001$). Internal consistency of each retained component was verified using Cronbach's alpha, with all components exceeding the 0.70 threshold (reported per component in Sections 4.1 and 4.2). The Relative Importance Index (RII) was used to rank the mitigation strategies; the strategy rankings were obtained from the five KII experts (not from the 101 survey respondents), each of whom independently ranked the ten strategies, and RII was computed from these expert rankings.

IV. RESULTS AND DISCUSSION

A. Causes of Skilled Labor Shortage

PCA of the 31 identified causes initially yielded eight components with eigenvalues exceeding 1.0, jointly explaining 66.20% of the total variance (see the scree plot in Figure 2). Of these, the first five components contained coherent, multi-item groupings of fifteen major causes with acceptable internal consistency and were retained for interpretation, collectively explaining 54.54% of the total variance.

Component 1, Personal Factors, emerged as the dominant component, accounting for 30.94% of the variance (eigenvalue = 9.283, $\alpha = 0.849$). From a Human Capital Theory perspective, this component reflects the erosion of human capital through inadequate investment in training and the absence of career development structures. The prominence of Personal Factors underscores that intrinsic worker dissatisfaction and inadequate career development structures are the primary drivers of labor shortage. Construction workers who lack hands-on training, feel undervalued, and see no viable career path are highly likely to abandon the profession in favor of foreign employment [2], [9]. This finding aligns with Bista et al. [14], who identified inadequate compensation, delayed payment, and excessive working hours as key drivers of labor dissatisfaction in Nepalese construction. It also aligns with Bhattarai et al. [15], who found that only 11.4% of workers were aware of annual increment entitlements and only 22.9% were aware of weekly leave provisions indicating that workers lack awareness of their entitlements, which contributes to low motivation and poor treatment perception.

Component 2, Developmental Factors (6.58% variance, eigenvalue = 1.974, $\alpha = 0.710$), included new technology adoption (0.596), lack of interest by youth (0.843), and economic changes (0.658). The high correlation of youth disinterest reflects the sector's persistent negative image, perceived as dirty, dangerous, and lacking prestige. Economic fluctuations further compound this issue, as boom periods create intense competition for labor while downturns force workers out of the industry, many of whom do not return when conditions improve. From a Labor Market Theory perspective, this component represents the demand-supply distortion created by changing economic conditions and evolving workforce preferences.

Component 3, Workplace Factors (6.49% variance, eigenvalue = 1.946, $\alpha = 0.702$), comprised safety issues (0.844) and unfavorable working environment (0.841). The strong correlation of both variables reflects the hazardous nature of construction work and the inadequacy of safety measures at many project sites in Kathmandu Valley. This component directly parallels the findings of Bista et al. [14], who identified unsafe working conditions and insufficient safety measures as primary factors driving worker dissatisfaction. Bohara et al. [17] further found that in Banke District, training programs (RII = 0.38) and safety measures required significant improvement, and only 46% of workers reported use of PPE and safety wear. Bhattarai et al. [15] found that while 90.5% of workers were aware of personal safety equipment, only 38.1% were aware that employers are obliged to provide necessary training indicating a significant gap between perceived safety and actual safety compliance. The convergence of findings across studies strengthens the evidence that workplace safety is a critical determinant of labor retention.

Component 4, Conflicts (5.47% variance, eigenvalue = 1.642, $\alpha = 0.742$), included family conflicts (0.865) and work conflicts (0.501). The demanding and inflexible nature of construction schedules frequently clashes with family obligations, while interpersonal conflicts at work sites create toxic environments that drive skilled workers away.

Component 5, Employment Factors (5.06% variance, eigenvalue = 1.518, $\alpha = 0.723$), captured growth of self-employment (0.712) and restrictions in hiring workers (0.774). The rise of self-employment reduces the pool of available workers for companies, while restrictive hiring regulations limit firms' ability to fill critical skill gaps [5], [11].

Table 2 presents the rotated factor loadings for all fifteen retained causes, together with the variance explained, eigenvalue, and Cronbach's alpha of each component.

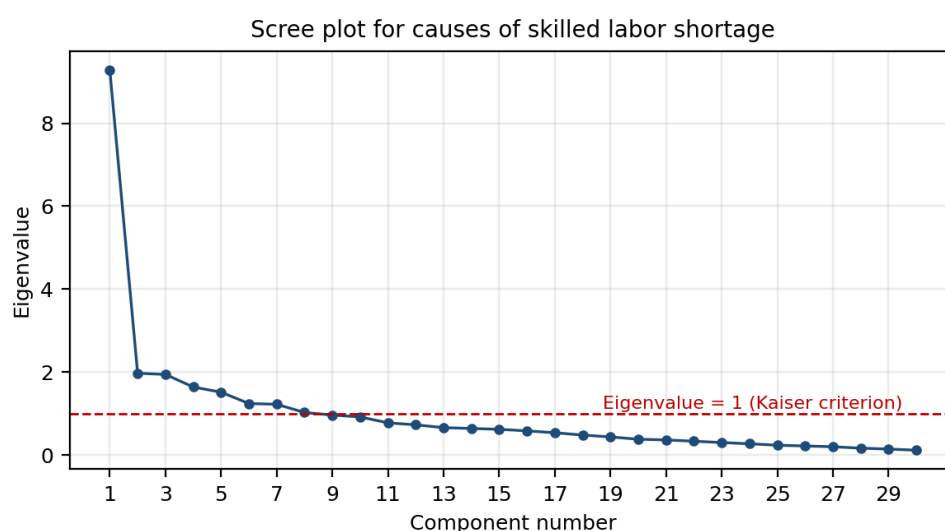


Figure 2: Scree plot for causes of skilled labor shortage

Table 2: Rotated component matrix for causes (Varimax with Kaiser normalization)

Component (variance; eigenvalue; α)	Cause variable	Loading	Eigen value	α
1. Personal Factors (30.94%)	Insufficient practical exposure	0.693	9.283	0.849
	Low motivation	0.858		
	Poor treatment of workers	0.766		
	No clear-cut career path	0.767		
2. Developmental Factors (6.58%)	New technology adoption	0.596	1.974	0.710
	Lack of interest by youth	0.843		
	Economic changes	0.658		
3. Workplace Factors (6.49%)	Safety issues	0.844	1.946	0.702
	Unfavorable working environment	0.841		
4. Conflicts (5.47%)	Family conflicts	0.865	1.642	0.742
	Work conflicts	0.501		
5. Employment Factors (5.06%)	Growth of self-employment	0.712	1.518	0.723
	Restrictions in hiring workers	0.774		

Theoretical Interpretation of PCA Components:

The five components map onto the theoretical framework as follows:

- Personal Factors reflect the failure of human capital investment where workers perceive insufficient returns on their skill development investments (low motivation, poor treatment, no career path) and where practical experience (human capital) is inadequately developed.
- Developmental Factors represent the structural challenges of human capital formation in the sector youth disinterest signals a failure to attract new human

capital, while technology adoption and economic changes alter the skill requirements and returns to existing human capital.

- Workplace Factors capture the role of working conditions in enabling or eroding human capital unsafe environments effectively devalue the human capital of skilled workers and drive them to seek safer employment elsewhere.
- Conflicts represent social capital dynamics family and work conflicts disrupt the stability needed for sustained human capital development and retention.
- Employment Factors reflect the Labor Market Theory dimension self-employment and hiring restrictions represent structural supply-demand distortions that exacerbate the shortage

B. Effects of Skilled Labor Shortage

PCA of the 24 identified effects yielded four components with eigenvalues exceeding 1.0, accounting for 62.97% of the total variance (see the scree plot in Figure 3).

Component 1, Technical Issues (43.50% variance, eigenvalue = 10.440, $\alpha = 0.820$), encompassed decrease in quality (0.756), material wastage (0.813), and rework (0.738). The dominance of Technical Issues highlights how the absence of skilled workers directly compromises construction quality, leading to material waste and costly rework. This finding is consistent with the quality effects documented in literature [3], [6], [7]. Bhattarai et al. [16] identified unavailability of skilled workforce as the second-ranked delay factor in retrofitting projects, with time overruns reaching up to 167% directly demonstrating the technical consequences of labor shortages.

Component 2, Health and Wealth Issues (8.42% variance, eigenvalue = 2.021, $\alpha = 0.857$), included effects on worker health (0.724) and financial well-being (0.753). When skilled workers are scarce, the remaining workforce faces excessive workloads and extended hours, leading to physical exhaustion and financial strain. This finding aligns with Bista et al. [14], who identified excessive working hours and inadequate compensation as key drivers of dissatisfaction, and with Bohara et al. [17], who found that wage delays and unpaid wages were serious issues in Banke District construction projects. Bhattarai et al. [15] similarly found that only 70.5% of workers received monthly remuneration within 3 days, and only 39% of casual workers received immediate payment—indicating widespread payment irregularities that affect financial well-being.

Component 3, Managerial Issues (6.08% variance, eigenvalue = 1.459, $\alpha = 0.759$), comprised difficulty in control and management (0.657), reduced participation of women workers (0.710), and feeling of overstress (0.712). Project management becomes significantly more challenging when supervisors must contend with understaffed teams and worker fatigue. Bhattarai et al. [15] found that female workers constitute only 28% of the construction workforce in their sample, highlighting gender disparity that may be exacerbated by labor shortages.

Component 4, Firm-level Managerial Deficiencies (4.97% variance, eigenvalue = 1.193, $\alpha = 0.724$), included inability to understand drawings and site conditions (0.626) and damage to company image (0.760). When unskilled workers replace skilled labor, their inability to interpret construction drawings leads to errors, while persistent quality problems tarnish the reputation of contracting firms [6], [7]. Bhattarai et al. [16] identified "lack of coherence in architectural, structural, electrical, sanitary, and HVAC drawings" as the third-ranked delay factor in retrofitting projects, which is compounded when unskilled workers cannot identify drawing inconsistencies.

Table 3 presents the rotated factor loadings for all ten retained effects across the four components

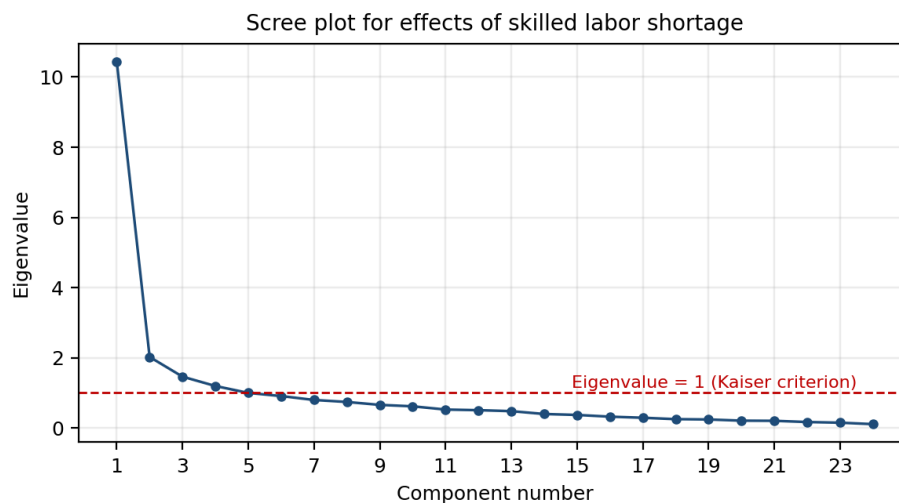


Figure 3: Scree plot for effects of skilled labor shortage

Table 3: Rotated component matrix for effects (Varimax with Kaiser normalization)

Component (variance)	Effect variable	Loading	Eigenvalue	α
1. Technical Issues (43.50%)	Decrease in quality	0.756	10.440	0.820
	Material wastage	0.813		
	Rework	0.738		
2. Health and Wealth Issues (8.42%)	Effect on worker health	0.724	2.021	0.857
	Effect on financial well-being	0.753		

Component (variance)	Effect variable	Loading	Eigenvalue	α
3. Managerial Issues (6.08%)	Difficulty in control and management	0.657	1.459	0.759
	Less share of women workers	0.710		
	Feeling of overstress by workers	0.712		
4. Firm-level Managerial Deficiencies (4.97%)	Inability to understand drawings and site conditions	0.626	1.193	0.724
	Damage to company image	0.760		

C. Strategies to Address Skilled Labor Shortage

Ten strategies were identified through Key Informant Interviews and ranked by RII computed from the independent rankings of the five experts. Table 4 presents the full ranking. Investment in training and development ranked highest (RII = 0.84), reflecting strong consensus that building a robust talent pipeline through apprenticeship programs and vocational partnerships is essential. Hiring from foreign countries ranked second (0.80), acknowledging that skilled workers from neighboring countries can provide immediate relief for critical skill gaps [6]. Focusing on younger generations ranked third (0.72), emphasizing outreach programs in schools to raise awareness about construction careers. Sub-contracting ranked fourth (0.68), as specialized subcontractors allow flexible workforce scaling, while making construction careers more attractive ranked fifth (0.64) [4], [5]. Because the RII values derive from a small expert panel ($n = 5$), dispersion statistics such as standard deviations would not be meaningful and are therefore not reported; the raw rank distributions underlying each RII are available from the authors.

Table 4: Strategies to address skilled labor shortage ranked by RII (KII experts, $n = 5$)

S.N.	Strategy	RII	Rank
1	Investment in training and development	0.84	1
2	Hiring from foreign countries	0.80	2
3	Focusing on younger generations	0.72	3
4	Sub-contracting / petty contracting	0.68	4
5	Making construction careers more attractive	0.64	5

S.N.	Strategy	RII	Rank
6	Embracing technology (e.g., BIM)	0.60	6
7	Improved industry image and outreach	0.56	7
8	Increased wages and benefits	0.52	8
9	Policy and regulatory provisions	0.52	8
10	Retention and development of existing workers	0.36	10

The remaining strategies in descending order were: embracing technology such as Building Information Modeling (RII = 0.60), improved industry image and outreach through public awareness campaigns (0.56), increased wages and benefits (0.52), policy and regulatory support including streamlined apprenticeship programs (0.52), and retention and development of existing workers (0.36). The relatively low ranking of retention strategies suggests that experts perceive the current workforce as already significantly depleted, making recruitment and new talent acquisition more urgent [7], [10].

Because these strategies were derived from a small qualitative expert panel and were not quantitatively validated for effectiveness or feasibility, Table 5 offers a preliminary feasibility appraisal synthesized from the KII discussions, indicating the principal implementation challenge, indicative time horizon, and primary responsible party for each of the top-ranked strategies. This appraisal is indicative rather than empirical and is proposed as a structured starting point for the future validation studies recommended in Section 5.

Table 5: Preliminary feasibility appraisal of top-ranked strategies

Strategy (RII)	Principal implementation challenge	Indicative horizon	Primary responsible party
Investment in training and development (0.84)	Sustained funding and curriculum alignment with site trades	Medium–long term (2–5 yrs)	CTEVT, DUDBC, contractors
Hiring from foreign countries (0.80)	Work-permit processing, wage competitiveness, social integration	Short term (<1 yr)	Ministry of Labour, contractors
Focusing on younger generations (0.72)	Overcoming negative image of construction careers in schools	Long term (5+ yrs)	Ministry of Education,

Strategy (RII)	Principal implementation challenge	Indicative horizon	Primary responsible party
			industry associations
Sub-contracting / petty contracting (0.68)	Quality control and contractual accountability of subcontractors	Short term (<1 yr)	Main contractors
Making careers more attractive (0.64)	Cost of improved benefits, career-ladder institutionalization	Medium term (1–3 yrs)	Contractors, FCAN

D. Comparison with Other Construction Sub-sectors in Nepal

Although this study is confined to building projects, the pattern of causes and effects identified here resonates with evidence from other construction sub-sectors and related studies in Nepal.

Studies of the hydropower sector report that the outmigration of skilled workers and site-level workforce constraints contribute, alongside financing and regulatory bottlenecks, to the chronic delays and cost escalations observed in large plants [19]. Similarly, cost-performance research on infrastructure projects internationally confirms that skilled-labor scarcity translates directly into overruns regardless of project type [7].

The convergence with findings from Bista et al. [14] on labor dissatisfaction in Nepalese construction is particularly noteworthy. Their study of a hospital construction project in Jajarkot identified delayed payment, inadequate wages, unsafe working conditions, excessive working hours, and insufficient safety measures as primary drivers of worker dissatisfaction. These dissatisfaction factors correspond directly to the Personal Factors (low motivation, poor treatment), Workplace Factors (safety issues, unfavorable environment), and Employment Factors (restrictions) identified in the present study.

Bhattarai et al. [15] assessed compliance and welfare in Kathmandu and found that workers had high awareness of safety-related duties (90.5% aware of using PPE) but low awareness of entitlements particularly medical insurance (7.6%), accidental insurance (3.8%), and annual remuneration increments (11.4%). This awareness gap suggests that while workers may be aware of their obligations, they are not adequately informed about their rights, making them vulnerable to exploitation and contributing to the Personal Factors (low motivation, poor treatment) identified in this study. The study also found no statistically significant gender differences in compliance perceptions, suggesting that labor issues affect male and female workers similarly,

though women face additional barriers due to lower representation and lack of transportation provisions.

Bhattarai et al. [16] studied retrofitting projects and identified unavailability of skilled workforce as the second-ranked delay factor ($RII = 0.766$), with time overruns reaching up to 167%. This directly demonstrates the technical and financial consequences of labor shortages. The study also identified impractical project schedules, lack of coherence in drawings, and material unavailability as other top factors all of which are exacerbated when skilled workers are unavailable to address these challenges.

Bohara et al. [17] assessed labor conditions in Banke District and found that workers were largely unaware of their rights, with poor working conditions including insufficient safety precautions, lack of social security, and weak labor law enforcement. Their RII analysis showed that regular toolbox talks (0.59) ranked highest among health and safety aspects, while accident rate (0.31) and adequate training programs (0.38) ranked lowest, suggesting significant room for improvement. These findings indicate that labor challenges are not confined to the Kathmandu Valley but are systemic across Nepal.

The concordance across these studies suggests that the Personal and Developmental cause components identified here foreign employment pull, youth disinterest, weak training pipelines, and enforcement gaps are economy-wide phenomena rather than building-sector idiosyncrasies. Moreover, the dissatisfaction and compliance gaps identified by these studies unsafe working conditions, insufficient safety measures, delayed payment, and lack of awareness of entitlements align closely with the Workplace Factors and Personal Factors components, confirming that safety concerns and worker rights awareness are systemic issues across Nepalese construction.

This alignment implies that the mitigation strategies ranked in Section 4.3, particularly national investment in vocational training and strengthening enforcement mechanisms, would yield benefits across the wider construction economy. Furthermore, addressing the dissatisfaction and compliance gaps identified in these studies ensuring timely payment, adequate compensation, safe working conditions, reasonable working hours, sufficient safety measures, and worker awareness of entitlements would directly address the Personal and Workplace Factors that this study identifies as primary causes of the skilled labor shortage.

V. CONCLUSIONS

This study systematically examined the shortage of skilled labor in building construction projects within Kathmandu Valley through a mixed-methods approach. The Principal Component Analysis revealed that Personal Factors—comprising insufficient practical exposure, low motivation, poor treatment of workers, and absence of clear career paths are the most significant contributors to the labor shortage, explaining nearly 31% of the total variance. Developmental, Workplace,

Conflict, and Employment Factors collectively account for an additional 24% of the variance, indicating that the labor shortage is a multifaceted problem driven by personal, organizational, and systemic forces operating in concert.

These findings are consistent with and reinforced by recent studies on labor dissatisfaction, compliance, and conditions in Nepalese construction. Bista et al. [14] identified delayed payment, inadequate compensation, unsafe working conditions, excessive working hours, and insufficient safety measures as key drivers of worker dissatisfaction. Bhattarai et al. [15] found significant gaps in worker awareness of entitlements such as medical insurance (7.6%), accidental insurance (3.8%), and annual increments (11.4%), while also identifying enforcement challenges including insufficient mechanisms and monitoring gaps. Bhattarai et al. [16] documented time overruns of up to 167% in retrofitting projects, with skilled workforce unavailability as the second-ranked delay factor. Bohara et al. [17] found serious issues in Banke District including inadequate training (RII = 0.38), lack of PPE (RII = 0.46), limited insurance coverage, and wage delays.

The effects are predominantly technical, with decreased quality, material wastage, and rework constituting the largest effect component at 43.50% of the variance. Health and wealth deterioration, managerial difficulties, and firm-level managerial deficiencies represent significant secondary effects. The strategy ranking indicates that investment in training and development, targeted hiring from foreign countries, and outreach to younger generations are the most effective measures. These findings underscore the need for a multi-pronged approach that simultaneously addresses root causes while building institutional capacity for workforce development. Critically, addressing the dissatisfaction and compliance gaps identified in related studies ensuring timely payment (only 70.5% receive monthly payment within 3 days [15]), adequate compensation, safe working conditions (accident rate RII = 0.31 [17]), reasonable working hours, sufficient safety measures, and worker awareness of entitlements would directly address the Personal and Workplace Factors that this study identifies as primary causes of the shortage [14][15][16][17].

Based on the findings, the following recommendations are proposed:

First, in the medium term (two to five years), the Council for Technical Education and Vocational Training (CTEVT), in partnership with DUDBC and Grade A contractors, should increase investment in vocational training and apprenticeship programs tailored to the specific skill requirements of Kathmandu's construction sector. This should include curriculum alignment with site trades and practical exposure components that address the "insufficient practical exposure" identified in Personal Factors. The Department of Urban Development and Building Construction (DUDBC) should take the lead in coordinating with CTEVT and industry associations to establish standardized training modules and certification pathways. Training programs should also incorporate safety awareness modules to address the safety concerns identified in both this study and related research [14][17]. Given that Bohara

et al. [17] found training programs had the second-lowest RII (0.38), significant improvement is urgently needed.

Second, over a longer horizon, the Ministry of Education and industry associations such as FCAN should implement initiatives to attract and retain younger generations through improved industry image, competitive benefits, and visible career progression pathways. Outreach programs in schools should emphasize the technical skills and career advancement opportunities in construction, countering the negative perception of construction as "dirty and dangerous" work. The Ministry of Labour, Employment and Social Security should work with the Ministry of Education to integrate construction career awareness into secondary school curricula.

Third, within one to three years, contracting firms should embrace and integrate advanced technologies such as Building Information Modeling to enhance productivity and reduce dependence on manual labor for repetitive tasks. Industry associations such as the Federation of Contractors' Associations of Nepal (FCAN) should facilitate technology transfer and capacity building among member firms, particularly Grade A contractors working on large-scale projects. This addresses the "new technology adoption" factor in Developmental Factors and can help attract younger workers by modernizing the industry's image.

Fourth, the Ministry of Labour, Employment and Social Security should advocate for supportive regulations that promote local workforce retention, facilitate immigration of skilled workers for specialized roles, and ensure fair treatment across the sector. This should include enforcement of timely payment provisions (addressing the finding that only 70.5% receive payment within 3 days [15]), establishment of minimum safety standards with enforcement mechanisms, and creation of career progression pathways that provide workers with clear advancement opportunities. The Ministry should also strengthen enforcement mechanisms Bhattarai et al. [15] identified insufficient mechanisms, resource constraints, and monitoring gaps as key challenges. Addressing the low awareness of insurance provisions (7.6% for medical, 3.8% for accidental [15]) should be prioritized through awareness campaigns and enforcement of employer obligations. The Ministry should also consider streamlining work-permit processes for skilled workers from neighboring countries to address immediate skill gaps.

Fifth, the Government of Nepal should prioritize the creation of a comprehensive labor welfare framework that addresses the social security gaps identified in related studies [17]. This should include mandatory health insurance coverage (currently only 7.6% awareness [15]), accidental insurance (3.8% awareness [15]), and social security provisions. The government should also implement regular monitoring and evaluation mechanisms to track compliance and address gaps in a timely manner, as recommended by Bhattarai et al. [15] and Bohara et al. [17].

Several limitations qualify the generalizability of these findings. The study deliberately focused on large-scale projects (contract value above NRs. 50 million)

executed by Grade A contractors within the Kathmandu Valley; the causes, effects, and strategy priorities identified here may therefore not extend to small- and medium-scale projects, to lower-grade contractors, or to regions outside the Valley, where labor market dynamics, wage structures, and training access differ. In addition, the mitigation strategies were elicited from a small expert panel and were not quantitatively validated for effectiveness or feasibility. The RII rankings of strategies are based on expert perceptions rather than empirical evidence of effectiveness. Future research should extend the scope to include small- and medium-scale projects and unskilled labor shortages, incorporate projects beyond the Kathmandu Valley, consider different types of construction such as infrastructure, hydropower, and industrial works, and quantitatively test the effectiveness and feasibility of the ranked strategies to provide a more comprehensive understanding of workforce challenges in Nepal's construction industry. Additionally, future studies should empirically validate the effectiveness of specific interventions such as training programs, safety improvement initiatives, and payment guarantee mechanisms using quasi-experimental or longitudinal designs.

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REFERENCES

- [1] Asian Development Bank, *Nepal: Sector Assistance Program Evaluation for the Urban Development and Water Supply and Sanitation Sectors*. ADB, Manila, 2012.
- [2] B. B. Akomah, L. K. Adjei-Kumi, and Z. Mustapha, "Skilled Labour Shortage in the Building Construction Industry Within the Central Region," *Baltic Journal of Real Estate Economics and Construction Management*, vol. 8, pp. 83–92, 2020.
- [3] A. Mistri, P. C. G. Pitroda, and J. R. Pitroda, "Analysis of Causes, Effects and Impacts of Skills Shortage for Sustainable Construction Through Analytic Hierarchy Process," *IJTIMES*, vol. 5, no. 5, pp. 168–176, 2019.
- [4] O. A. Aiyetan and D. Dillip, "System Dynamics Approach to Mitigating Skilled Labour Shortages in the Construction Industry: A South African Context," *Construction Economics and Building*, vol. 18, no. 4, pp. 45–63, 2018.
- [5] L. Tshele and J. N. Agumba, "Factors Influencing Labour Productivity on Construction Sites: A Literature Review," 2014.
- [6] K. Nighute and S. Mhaske, "Analysis of Factors Affecting Labour Productivity in Construction Industry," 2018.
- [7] T. S. Elbashbishy and I. H. El-adaway, "Assessing the Impact of Skilled Labor Shortages on Project Cost Performance," *Construction Research Congress*, pp. 361–370, 2024.

- [8] J. W. Creswell and V. L. Plano Clark, *Designing and Conducting Mixed Methods Research*. SAGE Publications, 2007.
- [9] B. E. Oseghale, D. A. Oseghale, and A. O. Aiyetan, "Factors Influencing Construction Labour Productivity in Nigeria," 2015.
- [10] J. K. Matemani and B. Ndunguru, "Strategies for Addressing Skilled Labour Shortage in the Construction Industry," 2019.
- [11] A. Kölling, "Restrictions in Hiring Workers and Their Implications for Labour Market Dynamics," 2022.
- [12] G. S. Becker, *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education*, 3rd ed. University of Chicago Press, Chicago, 1993.
- [13] R. G. Ehrenberg and R. S. Smith, *Modern Labor Economics: Theory and Public Policy*, 13th ed. Routledge, New York, 2018.
- [14] B. Bista, U. Neupane, and S. K. Bhattarai, "Identifying the Causes of Dissatisfaction of Construction Labour: A Case Study of Building Construction of Jajarkot District Hospital, Nepal," *Himalayan Journal of Applied Science and Engineering*, vol. 4, no. 2, pp. 63–78, 2024. doi: 10.3126/hijase.v4i2.62188.
- [15] S. K. Bhattarai, D. Dahal, and U. Neupane, "Assessment of Compliance and Welfare of Construction Workers at Selected Building Construction Project in Kathmandu: Implications for Labor Act Implementation," *Journal of Recent Activities in Infrastructure Science*, vol. 9, no. 1, pp. 25–44, 2024.
- [16] S. K. Bhattarai, L. Rayamajhi, S. Lamichhane, and S. Arayal, "Navigating Delays: A Comprehensive Study of Public Building Retrofitting Projects in Kathmandu Valley," *Journal of UTEC Engineering Management*, vol. 2, no. 1, pp. 37–52, 2024. doi: 10.5281/zenodo.13169684.
- [17] A. Bohara, U. Neupane, S. K. Bhattarai, and S. Rokaya, "Assessment of Labor Condition of Construction Workplace in Banke District, Nepal," *Mid-West University Journal of Engineering & Innovation*, vol. 1, no. 1, pp. 46–56, 2025. doi: 10.3126/mujoei.v1i1.91098.
- [18] A. Shiha and I. H. El-adaway, "Localized Multivariate Statistical Assessment of United States Construction Labor Shortages," *Journal of Construction Engineering and Management*, vol. 151, no. 8, article no. 04025097, 2025. doi: 10.1061/J.CEMD4.COENG-15702.
- [19] P. Bhatt and K. R. Joshi, "Hydropower Development in Nepal: Status, Opportunities and Challenges," *Journal of UTEC Engineering Management*, vol. 2, no. 1, pp. 125–135, 2024.