



OPEN ACCESS

EDITED BY

Hexu Liu,
Western Michigan University, United States

REVIEWED BY

Fatemeh Pariafsai,
Bowling Green State University, United States
I. Ketut Dharma,
Politeknik Negeri Bali, Indonesia

*CORRESPONDENCE

Prakash C. Bhattarai,
✉ prakash@kusoed.edu.np

RECEIVED 06 May 2025

ACCEPTED 14 August 2025

PUBLISHED 10 September 2025

CITATION

Bhattarai PC, Parajuli MN, Gautam S,
Paudel PK, Bhurtel A and Sharma A (2025)
Education–work transition: skill gaps in the
construction industry.
Front. Built Environ. 11:1623609.
doi: 10.3389/fbuil.2025.1623609

COPYRIGHT

© 2025 Bhattarai, Parajuli, Gautam, Paudel,
Bhurtel and Sharma. This is an open-access
article distributed under the terms of the
[Creative Commons Attribution License \(CC
BY\)](#). The use, distribution or reproduction in
other forums is permitted, provided the
original author(s) and the copyright owner(s)
are credited and that the original publication
in this journal is cited, in accordance with
accepted academic practice. No use,
distribution or reproduction is permitted
which does not comply with these terms.

Education–work transition: skill gaps in the construction industry

Prakash C. Bhattarai ^{1*}, Mahesh Nath Parajuli ¹,
Suresh Gautam ¹, Prakash Kumar Paudel ¹,
Anup Bhurtel ² and Amrita Sharma ¹

¹Kathmandu University School of Education, Dhulikhel, Nepal, ²Nepal Administrative Staff College, Lalitpur, Nepal

This study aimed to assess the skills gap between competency evaluations by employers and the self-perceived competencies of employees within the engineering sector of the construction industry. We also examined the foundational subject matter knowledge of graduate employees and their likelihood of acquiring such knowledge based on different variables like gender, ethnicity, infrastructure quality, and the quality of on-the-job training (OJT). Accordingly, we conducted a cross-sectional survey using a self-administered questionnaire, which was completed by 59 employers and 222 recent graduates. From the perspective of the employers, the findings indicate that the majority of graduates exhibit inadequate proficiency in soft skills, professional competencies, common technical skills, and trade-specific abilities. Furthermore, the graduates demonstrated limited subject matter knowledge, with an average score of only 50.98% on a basic knowledge assessment. The analysis also revealed that graduates with access to high-quality institutional infrastructure and OJT opportunities performed nearly twice as well on the foundational knowledge test compared to those with poorer-quality experiences in these areas. These results highlight the urgent need to revise the technical and vocational education and training (TVET) curriculum as well as strengthen collaborations between training institutions and industry stakeholders to ensure that graduate competencies are aligned with the labor market demands.

KEYWORDS

skills gap, construction sector, employers, graduate employees, curriculum, Nepal

1 Introduction

Technical and vocational education and training (TVET) efforts are important for skilling youths to enable them to become industry-ready. TVET programs stress upon the employment of youths by equipping them with practical knowledge and skills needed in various industries. TVET is one of the important wings of education and aims to prepare individuals, especially youth, for employment in different industries. In this context, TVET graduates are expected to be more employable than others, and TVET is regarded as a major factor contributing to the employment of youth through skills acquisition. TVET efforts are also crucial for catering to the current and future needs of the job market. Hence, the driving force of TVET is to fulfill the competencies in demand in the job market. The instrumental roles of TVET range from skill fulfillment of youth to economic prosperity of the nation. However, industries in underdeveloped and developing

economies often face numerous difficulties owing to the scarcity of a skilled labor force and mismatch of skills.

Despite the global recognition of TVET in skilling individuals and supporting employment (Felder et al., 2024), there are observable gaps in the skills supplied by TVET programs and those required by industries, making such skill gaps a persistent challenge in the job market. Although TVET curricula are expected to meet market demands, the needs of employers are gradually changing with changes in the market, international trade, technology, and other external factors. Moreover, the quality of TVET teaching and learning facilities impacts the quality of the competencies of graduates as they enter the job market (UNESCO-UNEVOC, 2020). As a result, there is a widening gap in the competencies needed by employers and those exhibited by graduate employees, which is also observable in the construction sector.

The issue of skill gap is pertinent in the South Asian region, where the population entering the labor market is growing. More than 100,000 youths from South Asia search for jobs every day, which is an alarming situation not only because the region is rapidly becoming the largest labor force but also given the fact that more than half of this population is likely to experience deviations from their education and skills acquired through the demand of employers by 2030 (UNICEF, 2019a). The gaps between education-led competencies and those expected by employers have caused South Asia to lag in providing a 21st-century workforce comparable to other regions. Among the South Asian countries, Nepal is known to have one of the youngest populations, implying that increasing numbers of youth are entering the job market (International Labour Organization, 2017). Hence, the issue of skills gap in the labor market of Nepal, particularly in terms of the construction industry, has affected the job market and is likely to worsen as the young population increasingly enters the job market; therefore, these concerns are the motivation for the present study.

2 Literature review

In this section, we summarize existing research pertaining to skill gaps, their causes and consequences, the specific context within the TVET and construction sectors of Nepal, and the various sociodemographic and educational factors influencing skill and knowledge acquisition.

2.1 Skills mismatch: causes and consequences in the labor market

The dynamics of the labor market can be analyzed at both the global and national levels. First, the shift in globalization has influenced the international market and enabled relatively easier movement of the labor force across the world. Moreover, the labor force of South Asia is characterized by lower wages (Pong-Sul, 2005; Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH and International Labour Organization, 2015) and mitigates the global shortage of skills (Ra et al., 2015); such trends offer enormous opportunities for the South Asian labor force, including Nepal. However, the skill gaps pose

barriers to migrant workers for earning higher wages (Pong-Sul, 2005; Nepal Skills for Employment Programme, 2018). Second, national-level job markets can experience positive changes through the supply of skilled and semi-skilled labor forces, with changes in the education system leading to better employment opportunities (UNICEF, 2019b). In this regard, the global increase in skills mismatch is a growing concern driven by several factors.

The specific shifts in globalization and industrialization, shifts in rapid technological and occupational profiles, increased labor mobility, and changes in wage rates are mainly responsible for the misalignments between the supply and demand of skills at the international level (Ra et al., 2015). While the mobility of people for employment purposes can be considered opportunities for both the employees and host countries, it can equally cause skill crises in the home countries, especially in underdeveloped countries like Nepal. The demand for engineering courses was ranked as second highest among all vocational training courses on a global scale (Manpower Group, 2025). However, there is still a lower preference for such education in Nepal. Furthermore, the dynamically changing market has caused the curricula to become outdated rapidly (Bajracharya, 2022), inducing a shortage in the labor market for the industry-necessary skills expected by employers (Guo et al., 2022). However, policies aimed at skills production for the construction industry (Chan and Dainty, 2007), adoption of updated technologies in the curricula and pedagogy (Wattananjana, 2025), adoption of competency frameworks within the curricula (Daryono et al., 2024), and the leadership of educational institutions preparing students for the world (Hoque, 2025) also largely determine the extent to which the skills are aligned with the expectations of the job market.

The impacts of such competency gaps are multifold. First, graduates entering the job market are left unemployed, causing a rise in the unemployment rates in South Asia, including Nepal (The World Bank Group, 2023). Second, employers continue to struggle to find a skilled workforce required to operate and run their industry as these deficits increase steadily (Manpower Group, 2025); globally, many employers have reported significant difficulties in acquiring talent in the recent post-pandemic period (Manpower Group, 2023). In the case of skills misalignment, employers are required to conduct training programs to fulfill these competency shortfalls of the new graduate employees after recruitment, which incur time and financial expenses. The impacts of these skill deficiencies are also observable in other domains, such as decreasing wage rates of the employees (Zhao et al., 2025), decline in the productivity and growth of the respective industries, and the subsequent delay in economic growth (Oke et al., 2018). Hence, the impacts of skill gaps extend from the industry to the national economy.

2.2 Skills gap in the construction sector in Nepal

Dedicated technical education courses often start from the prediploma level to master's level and above in universities. Among these, the Council for Technical Education and Vocational Training (CTEVT), which is the apex body of technical education and vocational training in Nepal, offers a wide range of short-term vocational training, 3-year diploma, and 18-month prediploma

courses in Nepal. There are a total of 274 short-term vocational training programs offered by a total of 1,560 private and CTEVT-affiliated institutions across the country; these institutions offer different skill courses related to the construction sector, such as plumbing, masonry, and electrician training. The CTEVT offers 33 diploma courses, of which the highest number (16 programs) are related to engineering; further, a total of 23 prediploma courses are offered, among which the highest number (eight programs) are in the engineering field (CTEVT, 2022). Hence, the construction sector constitutes a major share of the technical and vocational courses offered in Nepal.

Although the number of courses offered appears to be sufficient, there is a large gap in the curriculum compared to market needs, and the graduate employees were found to lack both hard and soft skills in the mechanical sector (Bhurtel, 2016). Therefore, skills misalignment in the construction sector in Nepal is mainly attributed to the technical education and vocational training curricula. Among the pertinent issues observed, a mechanism for effective coordination was found to be non-existent among the actors, particularly employers, owing to which standardization of the curricula is lacking overall (Asian Development Bank, 2015). Rijal (2021) pinpointed the deep centralization of such curricula, their poor implementation, and the negligible existence of stakeholders in curriculum development as the main reasons; they also suggested using locally relevant curricula with adequately skilled human resources, such as managers and instructors. Therefore, even though the curriculum is expected to meet industry needs, employers often complain that Nepal's technical and vocational system produces graduates lacking in the required competencies (Puri, 2024; Sharma, 2023).

Employers frequently struggle to find the required skills because of mismatches and the significant deficit of competencies demanded by the market. Despite the various vocational courses offered by the CTEVT, including those in the construction sector, the actual enrollment is significantly lower than the enrollment capacities of the providers. In particular, the actual intake in prediploma classes is much lower than the capacities of the TVET institutions (CTEVT, 2022). Meanwhile, Nepali citizens are often employed in unskilled or low-skill jobs in the international market. Although trained workers from Nepal face stiff competition abroad, which is already a challenge in the international job market (The Economist Intelligence Unit, 2013), approximately 75% of Nepali migrants were reported to be unskilled or have low skills (International Organization for Migration, 2019); this has subsequently exposed them to vulnerable work environments (Bajracharya, 2022; UNICEF, 2019a). Although literature shows that there are talent deficits across the vocational education system, the particular skill gaps in the construction sector remain understudied. Therefore, the present study aims to identify discrepancies between the skills acquired by prediploma graduate workers and the skills required by workers in the Nepali construction industry, in addition to assessing their basic subject matter knowledge levels. Hence, the following hypothesis is considered.

Hypothesis 1: There is a gap between the skills observed by the employers and those perceived by the employees.

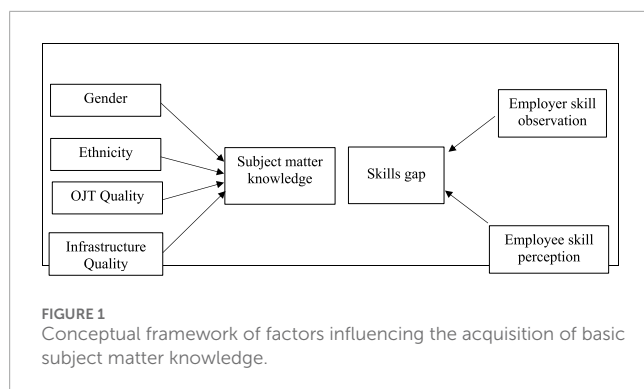
2.3 Sociodemographic and educational factors in knowledge and skills acquisition in TVET

As in other South Asian countries, female participation in TVET is low in Nepal (Lamichhane, 2013; Paudel, 2019). Even though the need for increased female enrollment and participation in these programs was found to have gained practical attention through various programs (Shoesmith and Collett, 2012), relevant studies still report lower enrollment of females in such courses. For instance, UNICEF (2019b) explains that the South Asian market still upholds bias against women because of gender-led stereotypes, marriage-related obligations, and continuity of traditional occupations involving risk factors. However, some studies (Minja et al., 2022) have shown lower learning levels of women in technical education and vocational training; such studies suggest that women are less likely to acquire knowledge and skills compared to men. Therefore, further studies are required to confirm whether male participants have higher skills acquisition in the construction sector in Nepal.

Among the different sociocultural factors, ethnicity plays a large role in vocational education participation and learning. In Nepal, Brahmins/Chhetris are advantaged groups with higher *per capita* gross domestic product (GDP); in contrast, the indigenous nationalities known as Janajatis and more so Dalits, whom Lamichhane (2013) has described as a designation for a group of people traditionally regarded as untouchable, are deprived ethnic groups (Asian Development Bank, 2015). In line with these findings, lower levels of participation have been observed in vocational training in Nepal in the past (Bhatta, 2016; Dahal, 2020). Even though a few studies have reported lower participation of Janajatis and Dalits, knowledge on the differences in their learning compared to Brahmins/Chhetris is limited.

Among the different educational factors, the physical infrastructures of the technical and vocational institutions significantly affect technical knowledge and skills acquisition. Unlike general education, technical and vocational education requires several kits, tools, equipment, and machines as part of skills development. The need for proper infrastructure has been well documented in extant literature (Asian Development Bank, 2015; Edel, 2020; Rijal, 2021; Tan and Seet, 2020). Accordingly, technical institutions were found to utilize information on global changes to upgrade their facilities or infrastructures (UNESCO-UNEVOC, 2020). The quality of vocational graduates in terms of their knowledge and skills acquisition is therefore strongly linked to the quality of the infrastructures at these institutions. However, such relationships are yet to be explored in the construction sector in Nepal.

TVET is primarily characterized by skills development for employment (Bhurtel, 2015; Sadekin et al., 2020), so it demands sufficient practice during the study hours as well as in the real job market. In this context, on-the-job training (OJT) is an essential requirement of such programs that are often facilitated by employers. Although educational institutions try to equip their learners with knowledge and practice, graduate employees still need to be trained on certain skills for two reasons. First, real work settings are often different and demanding than the conditions encountered



in institutions; second, skills needed in the workplace are often different, comprehensive, and output-oriented. Pulley (2006) noted that OJT aims to equip the workforce with the knowledge, skills, understanding, and motivation necessary to meet industrial needs. OJT allows industries to equip graduate workers with all the skills and techniques needed to perform their jobs; this enables the employees to feel competent while fostering their motivation, including positive wage changes (Rosholm et al., 2007). OJT is another important determinant in skills acquisition that makes the employees market-ready. However, its roles in learning skills in the construction sector need further research for knowledge substantiation. Therefore, in line with the research gaps identified in the various factors reviewed above, the following hypotheses are considered.

Hypothesis 2: Male graduate employees are more likely to acquire basic subject matter knowledge than female graduate employees.

Hypothesis 3: Graduate employees from Brahmin/Chhetri backgrounds are more likely to acquire basic subject matter knowledge than graduate employees from other ethnicities.

Hypothesis 4: Graduate employees who experience high quality of educational facilities/infrastructures are more likely to acquire basic subject matter knowledge than those who experience poor quality of educational facilities/infrastructures during the prediploma course.

Hypothesis 5: Graduate employees who experience high quality of OJT are more likely to acquire basic subject matter knowledge than those who experience poor quality of OJT during the prediploma course.

2.4 Conceptual framework

The conceptual framework of this study illustrates the hypothesized relationships between demographic and institutional factors as well as the employability outcomes of TVET graduates in Nepal, as shown in Figure 1. Specifically, it examines how gender, ethnicity, training infrastructures, and OJT influence the perceived knowledge and skill gaps among graduates entering the construction sector.

3 Research methods

In this study, we employed a quantitative research approach utilizing a survey design to systematically investigate the existing skill gaps within the construction industry in Nepal. The quantitative framework allowed the measurement of specific variables related to skill proficiency and industry needs, providing a robust empirical basis for identifying and quantifying discrepancies between the skills possessed by prediploma graduates and those demanded by employers.

3.1 Instrument

The present study utilized a self-constructed instrument developed through a rigorous multistage process. This involved an initial thorough review of the prediploma curricula for civil engineering, survey engineering, and water supply and sanitation engineering. Concurrently, consultations were carried out with stakeholders like instructors, principals, educators, prediploma graduates, and students from the supply side as well as owners of businesses/industries, employers, supervisors, workers, and graduate workers from the demand side. These consultations provided a deeper understanding of the specific needs and challenges in the construction and TVET sectors. Two questionnaires were developed thus, which were initially drafted in English and subsequently translated into Nepali by content and language experts.

The employer questionnaire gathered demographic data, such as position, experience, occupations offered, total employees, and their qualifications; it also inquired about recruitment strategies, the associated difficulties, and training provided by employers to graduate employees. A key component of this survey involved assessing the general workplace skills and curriculum-based competencies of employees. The employers evaluated soft skills based on 16 statements and professional skills based on 22 statements. The common technical skills assessed included computer-aided design (CAD) software (6 items), engineering drawing (9 items), construction materials (5 items), construction techniques (9 items), estimation and costing (5 items), entrepreneurial skills (3 items), and engineering survey (11 items). Additionally, the employers evaluated specific skills relevant to specialized areas, such as civil engineering, water supply, sanitation, and irrigation engineering; carpentry, plumbing, and electricity; gas welding and installation works; and survey engineering, GIS software, and survey methods. All skill assessments were based on a five-point Likert scale (1 = “very poor,” 3 = “good,” 5 = “excellent”), with a “not applicable” option provided for common technical skills.

The employee questionnaire included basic demographic variables, some of which overlapped with the employer version while others were unique (e.g., specific occupations, family background, and motivations for studying the construction sector); it also contained sections on perceived quality of the institutional facilities and infrastructure, instructional delivery, and OJT experiences. For the skill assessments, employees responded to an identical set of questions as those posed to the employers regarding curriculum-based, technical, and trade-specific skills on the same 5-point Likert scale. Furthermore, the employee questionnaire incorporated items

that directly assessed their basic subject matter knowledge relevant to the fundamental job roles expected from the curriculum.

3.2 Respondents and data collection

The respondents of this study were prediploma graduate workers currently working in the Bagmati and Lumbini provinces of Nepal as well as their respective employers. Among the employers, a total of 59 participants completed the survey questionnaire; this relatively small number of employers suggests the limited presence of employers in the job market. Among the employees, only those who had graduated from institutions in the past 2 years and had been working in the construction industry were included; here, a total of 1,100 graduate employees were initially contacted for the survey, of whom 222 completed the questionnaire.

3.3 Reliability and validity

The reliability of the instruments used in this study was primarily assessed through internal consistency of the multi-item scales used for the common and specific technical skills. Cronbach's alpha (α) was employed for this purpose, where an alpha value exceeding the generally accepted threshold of 0.7 (Table 4) was used to confirm the reliability of the test items. Similarly, the content validity, which refers to the extent to which the items in the instrument adequately and comprehensively represent the domain being measured, was rigorously established in the study during development of the instrument. This was achieved by systematically reviewing the prediploma curricula for the civil, survey, and water supply/sanitation engineering disciplines. As described in Section 3.1, extensive consultations were conducted with TVET experts/practitioners (representing the supply side) and industry employers (representing the demand side). These foundational steps ensured that the skills and knowledge items included in the questionnaires were highly relevant, comprehensive, and reflective of the competencies required in the construction sector in Nepal.

3.4 Data analysis

Various data analysis tools were employed considering the diverse objectives of this study. The knowledge and skills of the employees were initially explored using descriptive statistics, including frequency, percentage, mean value, and standard deviation. Similarly, to assess the skills gap, an independent samples *t*-test was conducted to determine any statistically significant differences between the skills observed by the employers and skills perceived by the employees. All basic assumptions of this parametric test were met before application, including the assumption of equal variances (assessed via Levene's test). Furthermore, the effect size and statistical power of the results were assessed to address potential issues with type II errors (Cohen et al., 2018).

To examine the likelihood of gaining basic subject matter knowledge based on gender (male/female), ethnicity, quality of infrastructures, and quality of OJT, we used binary logistic

regression. Basic subject matter knowledge was considered as the dependent variable (DV) and was a categorical variable with two levels, namely high and low, which made binary logistic regression suitable for this analysis. During the analysis, basic subject matter knowledge as the DV was coded using "0" for the low and "1" for the high levels, as detailed in Table 1.

The model of the logistic regression equation considered in this work was as follows:

$$\text{Logit}(P) = \log(P/(1-P)) = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \epsilon$$

where *P* is the probability of having a high level of basic subject matter knowledge, *X* represent the independent variables (gender, ethnicity, evaluation of infrastructure, and evaluation of OJT), *B* represent the coefficients of the corresponding independent variables, and ϵ is the error.

Table 1 details the operational model for the logistic regression and the coding scheme for the variables. As outlined, basic subject matter knowledge as the DV was dichotomized into high and low knowledge levels. Similarly, gender, ethnicity, infrastructure quality, and OJT quality as the independent variables were categorized as described in Table 1 to facilitate their inclusion in the binary logistic regression analysis. The odds ratio (OR) was employed to interpret the findings, where a value greater than 1 signifies a positive relationship between the independent variable and likelihood of the event (high basic subject matter knowledge) to indicate a higher probability of occurrence, while a value less than 1 denotes a negative relationship and a lower probability of occurrence of the event. Before implementing the logistic regression analysis, a multicollinearity test was performed to ensure that the independent variables were not excessively correlated, which could lead to unstable and biased regression coefficients. As detailed in Table 2, all tolerance values were robustly close to 1, and the variance inflation factor (VIF) values were comfortably lower than 2. These results confirm the absence of significant multicollinearity among the predictor variables, indicating that a reliable and unbiased logistic regression model could be produced.

3.5 Research ethics

This study was conducted upon receiving ethical approval from the Research Committee of Kathmandu University School of Education and adhered to all established ethical research guidelines. Prior to data collection, all respondents were clearly informed about the objectives of the study. Furthermore, no identifying information on the graduate employees or employers was collected or revealed during the survey, ensuring that the ethics of confidentiality were maintained rigorously. Moreover, the comfort and wellbeing of all respondents were prioritized and ensured throughout the data collection process.

4 Results

This section presents the findings from the two major data sources, namely the employers and employees. We first present

TABLE 1 Coding of the variables.

Variables	Description	Coding
Dependent		
Basic subject matter knowledge	A total of 27 questions asked under 14 themes and then averaged Sample statement: Most used pump for lifting water in water supply mains is called _____. (Four answers were provided, of which one was correct and the remaining three were incorrect.)	High subject matter knowledge with an average score of above 50% was coded as “1,” while low subject matter knowledge with an average score of 50% or below coded as “0.”
Independent		
Gender	Gender of the employee	Male coded as “0”; Female coded as “1”
Ethnicity	Ethnicity of the employee (Options: 1 = Brahmin, 2 = Chhetri, 3 = Janajati, 4 = Dalit, 5 = Others)	Brahmin and Chhetri coded as “0”; Janajati, Dalit, and Others coded as “1”
Quality of infrastructure	1 = Very poor, 2 = Poor, 3 = Good, 4 = Very good, 5 = Excellent	Very poor and Poor coded as “0”; Good, Very good, and Excellent coded as “1”
Quality of OJT	1 = Very poor, 2 = Poor, 3 = Good, 4 = Very good, 5 = Excellent	Very poor and Poor coded as “0”; Good, Very good, and Excellent coded as “1”

TABLE 2 Collinearity statistics.

Variable	Tolerance	VIF
Gender of the employee	0.973	1.028
Ethnicity of the employee	0.967	1.034
Quality of infrastructure	0.819	1.221
Quality of OJT	0.791	1.264

the sociodemographic and professional profiles of the respondents, followed by an assessment of the perceived competencies in construction-related knowledge and skills; finally, we present a statistical analysis of the skills gap and factors influencing knowledge acquisition.

4.1 Profiles of the graduate employees and employers

During the survey part of the study, we gathered the sociodemographic and professional characteristics of both the employer and employee participants. As summarized in [Table 3](#), the employer sample (N = 59) was predominantly male (98.3%), with a notable proportion identifying as Brahmin (40.7%) or Chhetri (27.1%). The employers represented a balanced mix of owners (30.5%) and immediate supervisors (32.2%), with over half the respondents possessing more than 5 years of experience (54.2%); this indicates a seasoned group of employers providing insights. The most frequently reported occupational opportunities available for employees were in building construction (26.8%) and surveying (23.2%), reflecting the demands of core civil engineering. Although

advertisement was the leading mode of recruitment (49.2%), informal channels like close contacts (22%) and OJT placements (18.6%) also played significant roles, suggesting the importance of informal networks in the construction sector of Nepal. Interestingly, most of the employers reported acquiring skilled workers as “somewhat easy” (33.9%) or “very easy” (35.6%), indicating that recruitment itself may not be their primary concern regarding workforce availability. This highlights that a significant part of hiring for the construction sector in Nepal is enabled by existing connections and practical experiences beyond formal recruitment, possibly because the employers trust the candidates owing to their past connections.

The employee sample (N = 222) also showed a male majority (78.4%), although there was a higher proportion of female participation (21.6%) compared to the employer group. [Table 3](#) illustrates the ethnic diversity among the employees, with Chhetri (34.2%) and Janajati (31.5%) being the largest groups, followed by Brahmin (19.8%). A significant majority of the employees (80.6%) were from agriculture-based family backgrounds, suggesting a potential shift in intergenerational occupational choices toward the construction sector. Consistent with the study’s focus on recent graduates, over three-quarters of the employees (75.6%) had less than 1 year of work experience, confirming the “fresh graduate” status of the participants. Similar to the results for the employers, the graduate employees identified surveying (35.6%), building construction (26.6%), and road and trail bridge construction (20.3%) as the key available occupations. Furthermore, social networks appeared to be the dominant mode of job acquisition for the employees (close contacts: 24.3%, internship/OJT: 28.8% combined as indirect social network involvement), highlighting the strong reliance on informal channels and personal networks. This shows that informal connections are crucial for entry into the construction field, which could be a hurdle for candidates without such ties.

TABLE 3 Summary of employer and employee sociodemographic and professional profiles.

Variable	Category	Employer (N = 59) count (%)	Employee (N = 222) count (%)
Gender	Male	58 (98.3%)	174 (78.4%)
	Female	1 (1.7%)	48 (21.6%)
Dominant ethnicity	Brahmin/Chhetri	40 (67.8%)	120 (54.0%)
	Ganapati/Dalit	16 (27.1%)	88 (39.6%)
Employer position	Owner/supervisor	37 (62.7%)	–
Employer experience	>5 years	32 (54.2%)	–
Employee's family occupation	Agriculture	–	179 (80.6%)
Employee experience	<1 year	–	168 (75.6%)
Mode of recruitment	Advertisement	29 (49.2%)	43 (19.4%)
	Internship/OJT placement	11 (18.6%)	64 (28.8%)
	Through close contacts	13 (22.0%)	54 (24.3%)
	Others	6 (10.2%)	41 (18.5%)
Ease of recruitment	Easy (Very/Somewhat)	41 (69.5%)	–
Top available occupations	Survey	32 (23.2%)	79 (35.6%)
	Building construction	37 (26.8%)	59 (26.6%)
	Road and trail bridge construction	27 (19.57%)	45 (20.3%)

4.2 Skill levels: employer observations and employee perceptions

The observations of the 59 employers and perceptions of the 222 employees participating in the survey on various domains of competencies revealed that the skills ranged from lower–medium to medium levels in all the key characteristics, as shown in [Table 4](#) (see also Supplementary Appendix S1). The employers reported higher competency levels on limited skills, such as construction techniques ($\bar{x} = 3.97$, $\sigma = 1.78$), installation works ($\bar{x} = 3.47$, $\sigma = 0.86$), and mechanical works ($\bar{x} = 3.24$, $\sigma = 1.13$); at the same time, they rated lower for several criteria like soft skills ($\bar{x} = 2.97$, $\sigma = 0.76$), road and trail bridge construction ($\bar{x} = 2.45$, $\sigma = 0.73$), estimation and costing ($\bar{x} = 2.74$, $\sigma = 0.94$), carpentry/plumbing/electricity ($\bar{x} = 2.53$,

$\sigma = 0.76$), and overall survey-based skills. Meanwhile, the employees perceived themselves to have acquired higher levels in control survey skills ($\bar{x} = 3.57$, $\sigma = 0.85$), mechanical skills ($\bar{x} = 3.46$, $\sigma = 1.00$), and soft skills ($\bar{x} = 3.42$, $\sigma = 0.77$). While the employer observations were lower for most of the skills, the employees perceived that their competencies were lower than those observed by the employers for construction techniques ($\bar{x} = 2.99$, $\sigma = 0.98$) and engineering drawing ($\bar{x} = 2.95$, $\sigma = 0.89$). This divergence between the employer observations and employee perceptions, especially in foundational areas like construction techniques and engineering drawing, highlights a potential mismatch in understanding what constitutes job-ready skills upon graduation.

4.3 Knowledge levels of the employees

The subject matter knowledge of the employees was assessed next; here, a total of 28 questions were asked under related headings, such as AutoCAD, building construction, or surveying, as shown in [Table 5](#). Most of the headings included at least two questions to assess employee knowledge levels as expected in the construction sector. We found that the employees scored more than 50% in only nine headings and more than 70% in only two headings out of the 15 headings. This shows that despite being graduates and entering the job market, the employees still lacked basic subject matter knowledge. Notably, graduates scored relatively low in crucial areas like electrical work (23.45%), water supply engineering (31.75%), road and trail bridge construction (36.18%), and engineering drawing (37.60%), pointing to clear gaps in their basic knowledge on these core construction fields.

For further analysis, subject matter knowledge level was categorized as “high” for scores above 50% and “low” for scores equal to or below 50%. The knowledge levels were assessed across gender and ethnicity, perceived quality of infrastructure of the educational institutions, and quality of OJT (see also Supplementary Appendix S2). Under the gender category, only 35.42% of women had high knowledge levels of the basic subject matter. Moreover, only 38.28% of the graduate employees who rated their institutions as having poor quality infrastructure demonstrated high levels of basic subject matter knowledge. Similarly, only 33.04% of the graduate employees who rated their OJT quality as poor had high basic subject matter knowledge. This represented the lowest observed percentage across all categories examined in this study. The strong links between better school facilities, OJT, and higher knowledge levels clearly demonstrate that some of the major determinants of quality education and hands-on experience entail preparing graduates with the right skills. Interestingly, high subject matter knowledge levels across Brahmins and Chhetris as opposed to other ethnic categories were balanced at nearly 50% each. Overall, the basic subject matter knowledge level across all categories remained concerningly low.

4.4 Gaps in various skills related to the construction sector

An assessment of the skill gaps in the construction sector revealed that the employer observations of the skills acquired by graduate employees were consistently lower than the employee self-perceptions

TABLE 4 Employer observations and employee perceptions of construction-based skills.

SN	Competencies	No. of items	Employer observations		Cronbach alpha	Employee perceptions		Cronbach alpha
			Mean	Std dev		Mean	Std dev	
General gap								
1	Areas of general understanding	5	3.13	0.67		-	-	
Curriculum gap								
1	Soft skills	16	2.97	0.76	0.933	3.42	0.77	0.954
2	Professional skills	22	2.88	0.73	0.947	3.36	0.76	0.961
Common technical skills								
1	Skills in AutoCAD software	6	2.93	1.13	0.918	2.99	0.98	0.910
2	Skills in engineering drawing	6	3.01	1.36	0.880	2.95	0.89	0.892
3	Competency regarding construction materials	5	3.24	1.27	0.846	3.25	0.87	0.910
4	Competency in construction techniques	9	3.97	1.78	0.969	2.96	0.91	0.945
5	Competency in estimation and costing	5	2.74	0.94	0.917	3.1	0.93	0.890
6	Proficiency in entrepreneurial skills	3	2.80	0.85	0.959	3.24	0.82	0.897
7	Proficiency in engineering survey	11	2.83	0.90	0.929	3.21	0.96	0.907

of such skills across nearly half of the examined skill sets. Hence, H_1 is partially accepted. Table 6 displays that the employer-observed levels of soft skills ($t = -5.35$, $p = 0.000$), professional skills ($t = -6.07$, $p = 0.000$), and the five core technical skills exhibited by employees were statistically significantly lower than the employee perceptions of these skills. Among the technical skills, the levels perceived by the graduate employees for AutoCAD software ($t = -2.07$, $p = 0.000$), construction materials ($t = -3.90$, $p = 0.000$), estimation and costing ($t = -3.19$, $p = 0.002$), entrepreneurship ($t = -3.93$, $p = 0.000$), and engineering survey ($t = -3.76$, $p = 0.000$) were lower than those observed by the employers. The clear and consistent differences between how employers viewed such skills and how employees perceived their own abilities across various soft skills, professional skills, and technical areas highlight a major mismatch in skill assessment that directly impacts workforce readiness.

Aside from the statistical significance, the practical implications of these skill gaps are further explained through Cohen's d effect sizes. There are notable disparities in the professional skills ($d = 0.906$) and soft skills ($d = 0.795$), which signify meaningful gaps in these core competencies. Medium amounts of practical differences are also evident across common technical skills related to construction materials ($d = 0.624$), entrepreneurship ($d = 0.559$), and engineering survey ($d = 0.550$). Collectively, these effect sizes confirm the practical

significance of the discrepancies in the observed skills and highlight the challenges in aligning employer expectations with employee self-perceptions. The statistical power associated with these findings further provides confidence in the results. While the statistical power for AutoCAD software was moderate at 0.591, the power for the remaining six skills was high and ranged from 0.80 to 0.999. The robust statistical power of most of these variables reinforces the reliability and generalizability of the observed discrepancies in skill acquisition between employer observations and employee perceptions. The significant effect sizes for the professional skills ($d = 0.906$) and soft skills ($d = 0.795$) are particularly worrisome; these broad skills are needed in almost any job, suggesting that graduates might find it difficult to adapt to or work well with others and not just on technical tasks. Moreover, the high statistical power of these findings (mostly 0.80–0.999) provides strong evidence that the observed skill gaps exist in the construction workforce.

4.5 Likelihood of gaining basic subject matter knowledge

Results on the likelihood of gaining basic subject matter knowledge were obtained using the logistic regression model, which

TABLE 5 Level of acquired basic subject matter knowledge.

SN	Topic for knowledge test	No. of questions	Correct answer
1	AutoCAD software	2	50.35%
2	Engineering drawing	2	37.60%
3	Road and trail bridge construction	3	36.18%
4	Carpentry	2	39.20%
5	Electrical	2	23.45%
6	Water supply engineering	2	31.75%
7	Surveying	2	57.30%
8	Estimation and costing	2	83.10%
9	Building construction	2	42.80%
10	Computer	2	64.20%
11	Entrepreneurship	1	78.4%
12	Masonry	2	59.90%
13	Plumbing	2	67.90%
14	Workplace-based safety	1	52.7%
15	Welding	1	35.6%
	Total	28	50.98%

n, number of questions asked.

highlighted the differences in knowledge levels across various variables, as shown in Table 7. The table shows the beta (β) values and ORs of logistic regression for each of the four categories of variables. Taking males as the reference group, we found that females were less likely to gain basic subject matter knowledge ($OR = 0.556, p > 0.05$). Similarly, taking Brahmins/Chhetris as the reference group, we found that other ethnic groups were more likely to gain basic subject matter knowledge ($OR = 1.302, p > 0.05$). However, since the effects are not statistically significant, the results cannot be generalized. Hence, H_2 and H_3 are rejected based on the p -value. Although the raw ORs suggest some directional tendencies (females less likely, other ethnic groups more likely), the statistical insignificance ($p > 0.05$) indicates that these observed differences could be attributed to random chance rather than any actual effect, thus preventing generalizable conclusions regarding the influences of gender and ethnicity on knowledge gain.

With regard to quality of infrastructure, poor quality of infrastructure was considered as the reference group, and we found that graduate employees who responded that their educational

institutes had high quality facilities were more likely to gain basic subject matter knowledge ($OR = 1.302, p < 0.05$). This result supports H_4 , indicating that high-quality infrastructure was pertinent to gaining basic subject matter knowledge. Similarly, taking poor OJT as the reference group, we found that graduate employees who reported receiving high-quality OJT were more likely to gain basic subject matter knowledge ($OR = 1.880, p < 0.05$). Hence, H_5 was also accepted. Both the quality of infrastructure and OJT exhibited positive effects on the likelihood of gaining knowledge; the higher the qualities of educational infrastructure and OJT, the higher the likelihood of gaining basic subject matter knowledge. This suggests that improving educational facilities and practical training programs is more instrumental in developing a more skilled construction workforce than focusing on demographic factors.

5 Findings and discussion

5.1 Graduate skills and knowledge deficiencies

One of the major findings of the present study is that both employer-observed and employee-perceived skills are at the lower medium level. Although the employer observations indicate relatively lower levels of skills acquired by the employees, the employee perceptions of skills are not anything more than moderate. We also found that most employees had only half of the expected levels of basic subject matter knowledge. This suggests that most graduate employees enter the job market with minimal competencies and consequently fail to satisfy employer expectations. Our study thus offers novel empirical evidence to the understanding of graduate competency levels within the construction sector in Nepal, which is often underrepresented in global skills research. One of the pertinent reasons behind the poor competency levels is the poor quality of TVET available. TVET is often pursued as a second option, which could prevent potential students from seeking TVET, particularly in the construction sector (The Economist Intelligence Unit, 2013). The quality of TVET has also been found to be inadequate in emerging economies and underdeveloped countries (Melesse et al., 2023). Ra et al. (2015) indicate that the quality of TVET available in underdeveloped and developing countries is attributable to the poorly designed curricula and pedagogy.

Poor learning of the graduate employees is mainly a result of a poor assessment system. The inability of fresh graduates to answer even half of the basic subject-matter-related questions raises numerous concerns about the quality of the assessment system in technical education in Nepal. As the apex body of TVET and of construction-based technical education in Nepal, the CTEVT is overburdened but continues to conduct the assessments by itself across the country. The limited abilities of the CTEVT have not only delayed publication of examination results but also resulted in poor quality of assessments and consequent poor competencies of the graduate employees, which are also observable in the construction sector. The present work critically highlights these context-specific systemic challenges within the Nepalese TVET sector and offers an understanding of how local institutional limitations are directly impacting graduate readiness. Among a

TABLE 6 Skill gaps between employer observations and employee perceptions.

Characteristics		Mean $\pm$ SD	Statistical <i>t</i> -test	<i>p</i>	Effect size	Statistical power
Soft skills	Employer	2.97 $\pm$ 0.54	−5.35 ^a	0.000	0.795	0.999
	Employee	3.42 $\pm$ 0.59				
Professional skills	Employer	2.87 $\pm$ 0.52	−6.07 ^b	0.000	0.906	0.999
	Employee	3.36 $\pm$ 0.56				
Technical skills						
AutoCAD software	Employer	2.74 $\pm$ 0.74	−2.07 ^b	0.000	0.322	0.591
	Employee	2.99 $\pm$ 0.81				
Construction materials	Employer	2.82 $\pm$ 0.62	−3.90 ^b	0.000	0.624	0.989
	Employee	3.25 $\pm$ 0.75				
Estimation and costing	Employer	2.74 $\pm$ 0.82	−3.19 ^b	0.002	0.452	0.868
	Employee	3.10 $\pm$ 0.77				
Entrepreneurship	Employer	2.80 $\pm$ 0.82	−3.93 ^b	0.000	0.559	0.967
	Employee	3.24 $\pm$ 0.75				
Engineering survey	Employer	2.83 $\pm$ 0.69	−3.76 ^b	0.000	0.550	0.963
	Employee	3.21 $\pm$ 0.69				

^aEqual variances not assumed.^bEqual variances assumed.For employers: *n* = 59; for employees: *n* = 222.

few key factors, the assessment system is critical to the success of technical education (Melesse et al., 2023). Therefore, such improvements must be addressed at the TVET policy level since the implementation of TVET programs should be uniform across the institutions. The quality of technical education assessments must also be upgraded to achieve higher retention of knowledge and greater competencies in the skills of graduates employed in the construction field.

5.2 Observed and self-perceived skill gaps

One of the highlights of the present study is that there is a wide skill gap in the construction sector in Nepal. By concurrently surveying both employers and graduate employees, this work uniquely provides a dual perspective on the observed versus self-perceived competencies. Furthermore, our quantification of discrepancies, particularly with regard to professional and soft skills through Cohen's *d* effect sizes, adds a novel empirical depth to available literature. The skill levels observed by employers are much lower than those perceived by the employees in all segments, including core technical, trade-specific, soft, and professional skills. Such gaps in the construction sector are prevalent in most of the growing economies in South Asia (KnightFrank, 2023; UNICEF, 2019b) as well as the world (Adepoju and Aigbavboa, 2021;

UNESCO-UNEVOC, 2017; Waidyasekara et al., 2022). The skill levels in the construction sector are mainly found to range from low to moderate; this signifies that employees are not receiving the knowledge and skills required in the rapidly changing job market.

While the lower skill levels discussed earlier contribute to these skill gaps, our findings hold a key interpretation. The curricula serving the construction sector in Nepal are not industry-specific and up to date. Ra et al. (2015) found that among the shifts in employment trends, the rapidly changing technologies adopted by industries require advanced technical knowledge, which in turn necessitates updating the skills of graduates. Within the curricula, the gap in soft skills also shows that the curricula have somewhat failed to emphasize soft and hard skills. TVET curricula should therefore include both hard and soft skills. When graduates enter the employment world, they are expected to exhibit soft skills like teamwork, organizational skills, and on-the-job behaviors (Asian Development Bank, 2015). Hence, a gap in soft skills also indicates a gap in the TVET curricula. In line with these causes, previous studies (Adepoju and Aigbavboa, 2021; Melesse et al., 2023) have suggested gearing up toward the needs of industries and technological changes. Ra et al. (2015) note that overly academic approaches to the TVET curricula used by South Asian institutions underscore the need for relevance in the curricula. The issue of a large skills gap can only be minimized by updating the curricula to ensure that the graduate employees are market-ready.

TABLE 7 Coefficients of the logistic regression for gaining basic subject matter knowledge.

Predictor variables	B	Se	Odds ratio
Gender			
Male (Ref.)			
Female	−0.587	0.354	0.556
Ethnicity			
Brahmin/Chhetri (Ref.)			
Others	0.264	0.289	1.302
Quality of infrastructure			
Poor-quality infrastructure (Ref.)			
High-quality infrastructure	0.622	0.310	1.862*
Quality of OJT			
Poor-quality OJT (Ref.)			
High-quality OJT	0.631	0.312	1.880*
Constant	−0.732		0.481

Nagelkerke $R^2 = 0.030$, * $p < 0.05$.

5.3 Institutional and policy responsibilities for workforce skill development

The findings from the logistic regression model used herein suggest that high-quality infrastructures and OJT increase the likelihood of gaining basic subject matter knowledge, suggesting the responsibilities of educational institutions. Despite the standard of curriculum, most educational institutions have a lot to offer; these institutions are responsible for providing modern equipment and machineries as well as facilitating cooperative training with the industry (Rasul et al., 2013). TVET institutions are expected to ensure effective pedagogy, provide sufficient physical resources for skill development, hire or retain well-trained instructors, engage in organizational visits, ensure proper implementation of assessments and conduct microassessments for quality assurance, strengthen partnerships with private firms and industries, and make appropriate arrangements for OJT, among others. Hoque (2025) highlight the instrumental roles of such educational leaders in understanding the demographic factors of the students as well as understanding the needs of external stakeholders like employers, communities, or the job market. It is also the responsibility of these institutions and policy developers to update their teaching-learning system with changing technologies. A recent study by Omrany et al. (2025) underscore the necessity of embedding new technologies in the curricula and infrastructure to enhance education and training in the construction industry. These factors are the baseline for reducing the skill gaps and increasing the quality of TVET overall.

Poor accountability mechanisms, absence of reward systems for high-performing TVET institutions, and high cost of

private education are some of the key constraints of TVET institutions in South Asia. Moreover, high politicization has been highlighted to affect institutional performance and the weak leadership of public TVET institutions in Nepal (Asian Development Bank, 2015). Hence, the authors highlight the need for capacity development, whereby the TVET institutions minimize the prevalent academic approaches while focusing on skills development and performance assessments. In line with this argument, KnightFrank (2023) further suggested that educational institutes should emphasize skill development, strengthening of training modules, promotion of the culture of coursework, and collaboration with private employers; these institutions also play roles in promoting global-centric education by providing necessary classes (including additional courses) to meet the demands of the industry.

OJT is another essential means of supplying the skills needed in the Asian job market, and the quality of OJT can be improved through the collaboration, facilitation, follow-up, and networking of TVET institutions. However, the quality of OJT provided is determined more by the employers and supervisors allocated to the OJT. In this connection, employers have stronger roles in improving OJT quality and the overall competency development of graduate employees. The prevalent skill gaps are also attributable to poor OJT since employers in South Asian countries, particularly small- and medium-sized firms, provide less OJT and invest very little in training efforts (Ra et al., 2015). Therefore, TVET policies and policymakers have additional roles in involving public and private employers in curriculum development/revision, industry-based training, and collaborations for other meaningful activities. The roles of TVET institutions and policies are thus instrumental in promoting education–employment linkage. The present study empirically links observed skills and knowledge deficiencies to specific systemic factors; the findings offer contextual and actionable policy recommendations beyond general calls for TVET reforms by emphasizing the need for improvements in curriculum, institutional, and employer capacities and examination systems, which are imperative for enhancing education–employment linkage and workforce readiness in the construction sector in Nepal through TVET.

6 Conclusion

In Nepal, many youths continuously enter the job market, where the construction sector is an essential contributor to employment. Therefore, TVET courses related to the construction sector are instrumental in fostering skills acquisition and addressing skill deficits. However, the present study underscores a persistent skills mismatch between employer expectations and the actual competencies of graduate employees. We found that numerous graduates enter the construction job market with minimal subject matter knowledge and skills below industry demands, yet perceive their skills to be significantly higher than the employer observations. Hence, this research sheds light on the nature and extent of the skill gaps within TVET in the construction sector in Nepal.

The study findings further emphasize the critical roles of educational institutions and regulatory bodies through improvements to the physical facilities and curricula as well as the

roles of employers through high-quality OJT. To bridge the skills gap, employer needs must be prioritized by involving them in curriculum development and regulatory roles. Furthermore, strengthening pedagogy and reforming the evaluation system are effective means of enhancing the competency levels of graduate students. Therefore, the sustainability and growth of Nepal's construction sector as one of the major outputs of TVET depends on addressing these identified skill deficiencies. Bridging these competency gaps can lead to a competitive construction workforce that contributes to national development.

7 Study limitations and research implications

While the present study provides empirical insights into the skill gaps within the construction sector in Nepal, it is important to acknowledge certain limitations to inform future research. First, we used a relatively small employer sample size ($N = 59$) in this study owing to their limited availability, which could affect the broader generalization of employer-specific findings. Therefore, future research should expand the sample size to ensure a stronger representation of employer perspectives. Second, drawing exclusively from the subjective self-reported data of graduate employees could introduce a potential for bias; future work should therefore integrate objective assessments to gather more factual data on skills acquisition. Third, the use of only quantitative data in the study limits deep exploration of the underlying reasons of the key findings, such as why the perceived skill levels of the graduate employees were higher than the employer observations or the factors contributing to their approximately 50% subject matter knowledge. Future mixed-methods research efforts incorporating qualitative inquiry could provide deeper insights into these complex phenomena. Lastly, our focus on the construction sector suggests that future studies could also be extended to other TVET sectors to offer a clearer picture of the skill gaps.

Data availability statement

The original contributions presented in this study are included in the article/Supplementary Material, and any further inquiries may be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by the Research Committee of Kathmandu University School of Education, Nepal. The studies were conducted in accordance with all local legislation and institutional requirements. The ethics committee/institutional review board waived the requirement of written informed consent for participation from the participants or their legal guardians/next of kin because oral consent was obtained as per the context.

Author contributions

PB: Conceptualization, Writing – original draft, Formal analysis, Supervision, Writing – review and editing, Methodology. MP: Writing – original draft, Funding acquisition, Conceptualization, Project administration, Supervision, Writing – review and editing, Methodology. SG: Conceptualization, Validation, Writing – review and editing, Methodology. PP: Methodology, Investigation, Writing – review and editing, Project administration. AB: Methodology, Conceptualization, Investigation, Writing – review and editing, Formal analysis, Writing – original draft. AS: Methodology, Project administration, Investigation, Conceptualization, Validation, Supervision, Formal analysis, Writing – review and editing.

Funding

The author(s) declare that financial support was received for the research and/or publication of this article. The authors acknowledge the funding support from the Swiss National Science Foundation and the Swiss Agency for Development and Cooperation for this study under the LELAM (Linking Education and Labour Markets) project in a collaborative international research initiative led by Kathmandu University in partnership with ETH Zurich.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Generative AI was used in the creation of this manuscript.

Any alternative text (alt text) provided alongside figures in this article has been generated by Frontiers with the support of artificial intelligence and reasonable efforts have been made to ensure accuracy, including review by the authors wherever possible. If you identify any issues, please contact us.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

References

- Adepoju, O. O., and Aigbavboa, C. O. (2021). Assessing knowledge and skills gap for construction 4.0 in a developing economy. *J. Public Aff.* 21 (3), e2264. doi:10.1002/pa.2264
- Asian Development Bank (2015). *Innovative strategies in technical and vocational education and training for accelerated human resource development in south Asia: Nepal*. Metro Manila, Philippines: Asian Development Bank. Available online at: <https://www.adb.org/publications/innovative-strategies-tvet-accelerated-hrd-south-asia-nepal> (Accessed July 02, 2025).
- Bajracharya, S. (2022). *Nepal economic Forum: overview of technical and vocational education in Nepal*, 22 August. Lalitpur, Nepal. Available online at: <https://nepaleconomicforum.org/overview-of-technical-and-vocational-education-in-nepal/> (Accessed July 25, 2025).
- Bhatta, K. (2016). Gender equality and social inclusion in vocational education and training. *J. Adv. Acad. Res.* 3 (2), 29–39.
- Bhurtel, A. (2015). Technical and vocational education and training in workforce development. *J. Train. Dev.* 1 (1), 77–84. doi:10.3126/jtd.v1i0.13094
- Bhurtel, A. (2016). Curriculum issues in Nepal: a study on graduates' perception. *J. Train. Dev.* 2 (1), 57–68. doi:10.3126/jtd.v2i0.15439
- Chan, P. W., and Dainty, A. R. (2007). Resolving the UK construction skills crisis: a critical perspective on the research and policy agenda. *Constr. Manage. Econ.* 25 (4), 375–386. doi:10.1080/01446190600863152
- Cohen, L., Manion, L., and Morrison, K. (2018). *Research methods in education*. 8th ed. London, UK: Routledge.
- Council for Technical Education and Vocational Training (2022). *Annual report 2078/79*. Bhaktapur, Nepal. Author.
- Dahal, S. K. (2020). Unequal access to TVET programmes in Nepal: impact of neo-liberalism. *J. Educ. Res.* 10 (1), 81–99. doi:10.3126/jer.v10i1.31900
- Daryono, R. W., Hidayat, N., Nurtanto, M., and Fu'Adi, A. (2024). The development of a competency framework for architectural engineering graduates: perspectives by the construction industry in Indonesia. *J. Technol. Sci. Educ.* 14 (2), 274–290. doi:10.3926/jotse.1986
- Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH and International Labour Organization (2015). *Labour market trends analysis and labour migration from south Asia to Gulf cooperation council countries, India and Malaysia*. Geneva, Switzerland: International Labour Organization. Available online at: <https://www.ilo.org/publications/labour-market-trends-analysis-and-labour-migration-south-asia-gulf-0> (Accessed July 25, 2025).
- Edel, M. (2020). Build4Skills, TVET, and infrastructure - an innovative initiative. In: B. Panth, and R. Maclean, editors. *Anticipating and preparing for emerging skills and jobs: key issues, concerns, and prospects*. New York, NY: Springer, Vol. 55. p. 291–296. doi:10.1007/978-981-15-7018-6_35
- Felder, A., Caprani, I., Kammernann, M., and Fedrigo, L. (2024). Transition of refugees into vocational training and guidance in companies. In: N. Kersh, and B. E. Stalder, editors. *Trends in vocational education and training research, vol. VII. Proceedings of the european conference on educational research (ECER), Vocational education and training network (VETNET)*. Zenodo. p. 144–153. doi:10.5281/zenodo.13238155
- Guo, Y., Langer, C., Mercorio, F., and Trentini, F. (2022). Skills mismatch, automation, and training: evidence from 17 European countries using survey data and online job ads. *EconPol Forum* 23, 11–15. Available online at: <https://www.econstor.eu/bitstream/10419/272126/1/1819068625.pdf> (Accessed August 28, 2025).
- Hoque, K. E. (2025). *The changing roles of educational managers: essential skills in an era of rapid change*. New York, NY: Springer. doi:10.1007/978-981-96-1086-0
- International Labour Organization (2017). *Labour market information and employment services (Life) project*. Geneva, Switzerland: International Labour Organization. Available online at: <https://www.ilo.org/projects-and-partnerships/projects/labour-market-information-and-employment-services-life> (Accessed July 25, 2025).
- International Organization for Migration (2019). *Nepal migration profile calls for upskilling of workers to compete in global job market*. Kathmandu, Nepal: International Organization for Migration. Available online at: <https://nepal.iom.int/news/nepal-migration-profile-calls-upskilling-workers-compete-global-job-market>
- KnightFrank (2023). *Skilled employment in construction sector in India*. London, UK: KnightFrank. Available online at: <https://nepal.iom.int/news/nepal-migration-profile-calls-upskilling-workers-compete-global-job-market> (Accessed July 25, 2025).
- Lamichhane, R. H. (2013). Hindering factors of female participation in TVET in Nepal. In: *Colombo Plan Staff College: Scholarly, Technical Education Publication Series*. Available online at: <https://www.cpsctech.org/2014/07/hindering-factors-of-female.html> (Accessed July 25, 2025).
- Manpower Group (2023). *In-demand technical skills*. Milwaukee, WI: Manpower Group. Available online at: https://www.manpowergroup.co.uk/c_the-most-in-demand-tech-jobs-in-2023/ (Accessed July 25, 2025).
- Manpower Group (2025). *2023 manpower group global talent shortage*. Milwaukee, WI: Manpower Group. Available online at: <https://manpower.com.tr/en/blog/research-insights/2023-talent-shortage#:~:text=According%20to%20the%202023%20results,39%20thousand%20employers%20from%2041> (Accessed July 25, 2025).
- Melesse, S., Haley, A., and Wärvik, G. B. (2023). Bridging the skills gap in TVET: a study on private-public development partnership in Ethiopia. *Int. J. Train. Res.* 21 (3), 171–186. doi:10.1080/14480220.2022.2159854
- Minja, J. J., Mbura, O. K., and Charles, G. (2022). The influence of trainees' characteristics on the transfer of entrepreneurship training: evidence from microfinance institutions in Tanzania. *Int. J. Train. Dev.* 26 (3), 448–471. doi:10.1111/ijtd.12266
- Nepal Skills for Employment Programme (2018). *Skills gap analysis by sector report*. Kathmandu, Nepal. Available online at: https://seepnepal.com/media/1101/skills-gap-analysis_inception-phase.pdf (Accessed July 25, 2025).
- Oke, A., Aigbavboa, C., and Khangale, T. (2018). Effect of skills shortage on sustainable construction. In: *International conference on applied human factors and ergonomics*. Cham: Springer International Publishing. p. 303–309.
- Omran, H., Al-Obaidi, K. M., Ghaffarianhoseini, A., Chang, R. D., Park, C., and Rahimian, F. (2025). Digital twin technology for education, training and learning in construction industry: implications for research and practice. *Eng. Constr. Archit. Manage.* doi:10.1108/ECAM-10-2024-1376
- Paudel, A. (2019). Girls' transitions to work through higher-quality TVET programs in Nepal. *Policy Paper, Echidna Global Scholars Program, Center for Universal Education, Brookings Institution*. Available online at: https://www.brookings.edu/wp-content/uploads/2019/10/AnilPaudel_Girl-transitions-to-work-through-higher-quality-TVET-programs-in-Nepal.pdf (Accessed July 02, 2025).
- Pong-Sul, A. H. N. (2005). Prospects and challenges of out-migration from south Asia and its neighbouring countries. *Labour Dev.* 11 (1), 1–23. Available online at: <https://library.fes.de/pdf-files/gurn/00352.pdf> (Accessed August 28, 2025).
- Pulley, P. A. (2006). On-the-job-training: easy to do if you have the right program. *Online J. Workforce Educ. Dev.* 2 (2). Available online at: <https://opensiuc.lib.siu.edu/ojwed/vol2/iss2/4/> (Accessed July 25, 2025).
- Puri, A. (2024). Skills mismatch in entry-level programmer positions: employer expectations vs. observations in Lalitpur, Nepal. *Master's thesis* 14, 1–135. doi:10.51474/jer.v14i1.733
- Ra, S., Chin, B., and Liu, A. (2015). *Challenges and opportunities for skills development in Asia: changing supply, demand, and mismatches*. Mandaluyong, Philippines: Asian Development Bank.
- Rasul, M. S., Abd Rauf, R. A., and Mansor, A. N. (2013). Employability skills indicator as perceived by manufacturing employers. *Asian Soc. Sci.* 9 (8), 42–46. doi:10.5539/ass.v9n8p42
- Rijal, N. (2021). Desktop study: Challenges in curriculum development of technical and vocational education in preparation for 21st century to Nepal. *SSRN* 3813005. doi:10.2139/ssrn.3813005
- Rosholm, M., Nielsen, H. S., and Dabalen, A. (2007). Evaluation of training in African enterprises. *J. Dev. Econ.* 84 (1), 310–329. doi:10.1016/j.jdeveco.2005.11.008
- Sadekin, M. N., Ahamad, K. M. U., and Chowdhury, N. F. H. (2020). Technical and vocational education and training (TVET) in south Asia. In: *Decent work and economic growth*, Cham: Springer. p. 1–12. doi:10.1007/978-3-319-71058-7_127-1
- Sharma, A. (2023). *Employability in ICT sector in Nepal: an explanatory sequential mixed methods study*. Hattiban, Lalitpur: Kathmandu University School of Education. Doctoral thesis.
- Shoesmith, K., and Collett, K. (2012). *Gender and skills development*. Paris, France: UNESCO-UNEVOC. Available online at: <https://unesdoc.unesco.org/ark:/48223/pf0000217859> (Accessed July 25, 2025).
- Tan, S. H., and Seet, I. (2020). Infrastructure and pedagogy innovation - a differentiating factor in TVET. In: B. Panth, and R. Maclean, editors. *Anticipating and preparing for emerging skills and jobs: key issues, concerns, and prospects*. Cham: Springer, Vol. 55. p. 109–115. doi:10.1007/978-981-15-7018-6_14
- The Economist Intelligence Unit (2013). *Skills development in south Asia: trends in Afghanistan, Bangladesh, India, Nepal, Pakistan, and Sri Lanka*. Stratford, London: British Council.
- The World Bank Group (2023). *Unemployment, youth total (% of total labor force ages 15-24) (modeled ILO estimate) - south Asia, 25 April*. Washington, DC: The World Bank Group.

UNESCO-UNEVOC (2017). *Bridging Benin's skills gap: partnerships with private enterprises in agricultural TVET*. Paris, France: UNESCO-UNEVOC. Available online at: https://unevoc.unesco.org/pub/nqc_bridging_benins_skills_gap.pdf (Accessed July 25, 2025).

UNESCO-UNEVOC (2020). *UNESCO-UNEVOC study on the trends shaping the future of TVET teaching*. Paris, France: UNESCO-UNEVOC. Available online at: <https://unesdoc.unesco.org/ark:/48223/pf0000374119> (Accessed July 25, 2025).

UNICEF (2019a). *Developing skills in youth to succeed in the evolving South Asian economy: nepal country report*. New York, NY: UNICEF. Available online at: <https://www.unicef.org/rosa/topics/unemployment> (Accessed July 25, 2025).

UNICEF (2019b). *More than half of South Asian youth are not on track to have the education and skills necessary for employment in 2030*, 29 October. New York,

NY: UNICEF. Available online at: <https://www.unicef.org/press-releases/more-half-south-asian-youth-are-not-track-have-education-and-skills-necessary> (Accessed July 25, 2025).

Waidyasekara, K. G. A. S., Ridmika, K. I., Sandagomika, N. M. G. H., and Konara, A. N. (2022). Analysing the skill gaps of plant and equipment operators in building construction projects in Sri Lanka. *FARU J.* 9 (1), 65–76. doi:10.4038/faruj.v9i1.123

Wattanajantra, A. (2025). *How tech-driven strategies can solve your construction skills shortages*. United Kingdom. Available online at: <https://www.sage.com/en-gb/blog/construction-skills-shortages-tech-driven-strategies/#gate-b1a63862-3fa0-4a5e-bb67-c76b88bbc6b8> (Accessed July 25, 2025).

Zhao, X., Wu, D., and Wang, L. (2025). Wage effect and workers' skill mismatch: paths and mechanisms. *SAGE Open* 15 (1), 21582440251318540. doi:10.1177/21582440251318540