

Construction Labour Shortage Causes Impacts and Solutions

Posted on May 30, 2018

According to the report (Construction, 2025), some industries experience a boom, but the construction sector does not. Previously, the construction sector faced problems related to low demand. However, the current problem is different as there is a huge demand in the market, but the workforce, which is the main sector to fulfill that demand, is absent or limited, which leads to the issue of huge vacancies. In addition to this, an ageing workforce is another area of concern for the construction industry. These labour shortages and ageing workforce issues can also adversely affect the overall industry in the long run. Hence, this research is carried out to assess the labour shortage's impact on the construction sector productivity, economic growth, and project delivery. To accomplish the research purpose, it is important to address the research question, which includes what is the shortfall of labour issue in the construction industry, how it impacts the production as well as the growth in the sector and what are the reasons behind such issue. The research is based on secondary data collection. Data was gathered from journals, online resources, books, and research papers. Thematic analysis is performed in which main themes related to the issue and impacts were developed. It is concluded that the workforce shortfall causes many serious issues like project delays, poor work quality, reduced productivity, increased cost of labour, and a decline in economic growth. The reasons behind this issue include an ageing workforce, poor industry perception, rising construction activities, and a lack of skilled labour. The construction companies and governments need to take proper measures to resolve this issue, such as offering good pay, developing training programs, encouraging young people to join the sector and introducing technology.

Introduction

1.1 Background

The construction industry has a significant influence on the economy and is associated with different sectors like manufacturing, real estate, transport, and mining. It also creates several employment opportunities and is a large contributor to GDP. The construction sector includes the building of commercial properties, housing, roads, bridges, airports, and different infrastructure projects. It is dependent on human labour, as several construction activities require specialized workers, manual effort, and skilled professionals. The industry includes workers such as plumbers, electricians, engineers, architects, carpenters, bricklayers, machine operators, supervisors, and labourers.

The construction industry has recently experienced strong demand due to population growth, urbanization, infrastructure development, housing requirements, and government investment.

However, labour supply has not increased at the same pace. Many construction companies face difficulties in recruiting and retaining skilled and unskilled workers. This has created a labour shortage that affects project completion, quality, cost, safety, and productivity.

A labour shortage occurs when employers cannot find enough qualified workers to fill available jobs. It may result from an overall lack of workers, a shortage of specific skills, regional mismatches, low wages, poor working conditions, or competition from other sectors. In construction, shortages are especially challenging because projects require different trades at specific stages. If one trade is unavailable, the entire project schedule may be disrupted.

The ageing workforce is another major concern. Many experienced construction workers are approaching retirement, while fewer young people are entering the industry. When experienced workers leave, companies lose technical knowledge, practical skills, and supervisory capacity. The replacement workforce may not have adequate training or experience.

The negative image of construction work also contributes to labour shortages. Young people may view construction as physically demanding, unsafe, unstable, or less prestigious than office-based careers. Schools and parents may encourage university education rather than vocational training. As a result, construction apprenticeships and technical programs may receive fewer applicants.

The labour shortage has become a global issue. Developed countries experience ageing populations and low participation in skilled trades, while developing countries may have a large labour force but insufficient training. Migration policies, economic cycles, public health crises, and changes in worker preferences can also influence labour availability.

This study examines the labour shortage in the construction industry, its causes, and its effects on productivity, economic growth, and project delivery. It also discusses strategies that can help governments, educational institutions, and construction companies address the problem.

1.2 Problem Statement

The construction sector is experiencing a shortage of skilled and unskilled workers despite strong market demand. The shortage contributes to delayed projects, rising labour costs, reduced productivity, lower work quality, and safety concerns. It may also limit infrastructure development and economic growth. The ageing workforce and inadequate entry of young workers indicate that the problem may become more serious in the future. Therefore, it is necessary to understand the nature, causes, and consequences of the labour shortage and identify practical solutions.

1.3 Research Aim

The aim of this study is to examine the impact of labour shortages on construction-sector

productivity, economic growth, and project delivery and to identify the major causes and possible solutions.

1.4 Research Objectives

The objectives of the study are:

1. To explain the labour shortage in the construction industry.
2. To identify the major causes of construction labour shortages.
3. To examine the impact of labour shortages on project delivery.
4. To assess the effect on productivity, costs, quality, safety, and economic growth.
5. To recommend strategies for improving labour supply and workforce capability.

1.5 Research Questions

The research addresses the following questions:

1. What is the nature of the labour-shortage problem in the construction industry?
2. What factors contribute to the shortage of construction workers?
3. How does the shortage affect productivity and economic growth?
4. How does it influence project delivery, quality, safety, and cost?
5. What strategies can reduce the construction labour shortage?

1.6 Significance of the Study

The study is significant to construction companies, project managers, policymakers, training institutions, workers, and investors. Understanding the causes of labour shortages can help organizations develop effective recruitment, retention, and training strategies. Governments can use the findings to improve vocational education, migration policies, and infrastructure planning. Better workforce planning can support timely project completion and economic development.

Literature Review

2.1 Importance of the Construction Industry

The construction industry supports economic development through infrastructure creation, employment generation, and demand for materials and services. Roads, transport systems, energy facilities, hospitals, schools, housing, and commercial buildings enable other sectors to operate efficiently. Construction spending has a multiplier effect because it creates demand for cement, steel,

timber, machinery, logistics, professional services, and finance.

The sector also provides employment to people with different education and skill levels. It includes professional, technical, supervisory, trade, and general-labour positions. However, the project-based and cyclical nature of construction can create instability in employment. During downturns, workers may leave the industry and not return when demand recovers.

2.2 Concept of Labour Shortage

A labour shortage exists when labour demand exceeds supply at prevailing wages and working conditions. It may be quantitative, meaning too few workers are available, or qualitative, meaning available workers do not possess the required skills. Shortages can occur nationally, regionally, within particular trades, or during periods of high construction activity.

Vacancy rates, recruitment time, wage growth, overtime, project delays, and employer surveys may indicate a shortage. However, shortages can also reflect unattractive employment conditions rather than an absolute lack of people. If wages, security, training, and working conditions improve, more people may enter or remain in the sector.

2.3 Skilled Labour Shortage

Skilled trades require training, practical experience, certification, and knowledge of construction standards. Electricians, plumbers, welders, carpenters, equipment operators, and other specialists cannot be replaced quickly. Training may require several years, and the quality of work depends on experience.

A shortage of skilled workers can create bottlenecks because one trade may be required before another can begin. For example, electrical and plumbing work must be completed at specific stages before walls and finishes are closed. If skilled trades are unavailable, the project schedule is affected.

2.4 Ageing Workforce

The ageing workforce is a central cause of labour shortages. Experienced workers are retiring, while the number of new entrants is insufficient. Older workers possess tacit knowledge developed through years of practice. This knowledge includes problem-solving, sequencing, quality control, safety judgment, and coordination with other trades.

Retirement creates both a numerical and knowledge gap. If companies do not implement succession planning, mentoring, and knowledge transfer, younger workers may take longer to reach full productivity. Physical demands can also make it difficult for older workers to continue in site-based

roles.

2.5 Low Participation of Young People

Many young people prefer careers perceived as safer, cleaner, more stable, and more prestigious. Construction may be associated with physical labour, outdoor exposure, early hours, travel, temporary contracts, and safety risks. Limited awareness of career progression and earning potential can reduce interest.

Education systems may prioritize academic pathways over technical and vocational education. Schools may provide insufficient information about apprenticeships, digital construction, engineering, project management, and skilled trades. Gender stereotypes and lack of diversity also restrict the potential workforce.

2.6 Training and Skills Gap

The skills gap occurs when workers' abilities do not match industry requirements. New construction methods, sustainability standards, digital tools, and regulations require updated skills. Building information modelling, off-site manufacturing, automated equipment, energy-efficient systems, and smart technologies are changing job requirements.

Training programs may not align with current industry needs. Employers may be reluctant to invest in training because workers can leave for competitors. Small firms may lack resources to run apprenticeships. Economic downturns can also reduce training, creating shortages when demand returns.

2.7 Industry Image and Working Conditions

Construction work can involve physical strain, weather exposure, noise, dust, travel, irregular schedules, and safety hazards. These conditions affect recruitment and retention. Temporary contracts and project-based employment may create income uncertainty. A workplace culture that lacks inclusion can discourage women and underrepresented groups.

Improving safety, welfare facilities, employment security, respect, and career development may make construction more attractive. Public communication should present the industry's professional, technical, and innovative opportunities rather than only manual labour.

2.8 Economic Cycles

Construction activity is sensitive to economic cycles, interest rates, property demand, and public investment. During recessions, companies reduce employment and training. Workers may move to other industries. When construction demand increases again, the workforce cannot be rebuilt immediately.

Rapid expansions can therefore produce shortages. Large infrastructure programs may compete with private construction for the same workers. Regional booms can attract labour away from other areas and increase wage pressure.

2.9 Migration and Labour Mobility

Migrant workers are important to construction in many countries. They can fill shortages, support major projects, and provide specialized skills. Changes in immigration policy, visa rules, exchange rates, political conditions, or public health restrictions can reduce migrant labour supply.

Worker mobility is also influenced by housing costs, transport, family commitments, and regional wage differences. Projects in remote areas may struggle to attract workers unless accommodation and travel support are provided.

2.10 Impact on Productivity

Labour shortages can reduce productivity because inexperienced workers may require more supervision and take longer to complete tasks. Existing workers may work overtime, leading to fatigue and mistakes. Crews may be incomplete or poorly balanced, and work sequencing may be disrupted.

Productivity is also affected when managers spend time recruiting, rearranging schedules, or responding to shortages instead of managing performance. Skilled workers may perform tasks below or outside their normal specialization, reducing efficiency.

2.11 Impact on Project Delivery

A shortage of labour can delay project start dates and extend construction schedules. Contractors may be unable to mobilize required crews or complete activities on time. Delays in one trade can affect dependent tasks and create cascading schedule problems.

Projects may incur liquidated damages, financing costs, extended equipment rentals, and administrative expenses. Clients may lose revenue if buildings or infrastructure are completed late.

Contractors may also decline work because they lack capacity, limiting competition and increasing prices.

2.12 Impact on Cost

When demand for labour exceeds supply, wages and subcontractor prices increase. Companies may pay recruitment bonuses, overtime, travel allowances, or agency fees. Rework and low productivity further increase costs. Contractors may include labour-risk premiums in bids, resulting in higher construction prices.

Cost escalation can make projects financially unviable or reduce the scope of planned developments. Public-sector budgets may fund fewer projects, while housing affordability can be affected by increased construction costs.

2.13 Impact on Quality

Quality may decline when inexperienced or insufficiently trained workers perform specialized tasks. Pressure to meet schedules can lead to shortcuts and inadequate inspection. Rework may increase, causing additional delay and cost.

Experienced tradespeople understand tolerances, materials, sequencing, and standards. Their absence can reduce craftsmanship and increase defects. Strong supervision and quality-control systems are therefore particularly important during labour shortages.

2.14 Impact on Safety

Labour shortages can increase safety risks through fatigue, overtime, inadequate supervision, and the use of inexperienced workers. Employees may be assigned unfamiliar tasks or work with incomplete crews. Language barriers and rushed induction can also affect safety communication.

Construction is already a high-risk industry. Workforce shortages must not lead companies to weaken training, competency checks, or safe-work procedures. Accidents create human suffering, delay, legal liability, reputational damage, and financial cost.

2.15 Impact on Economic Growth

Construction labour shortages can constrain economic growth by delaying infrastructure, housing, and commercial investment. Inadequate transport, energy, and public facilities can reduce productivity in other industries. Housing shortages may increase costs and limit labour mobility.

If construction capacity cannot meet demand, public investment plans may be postponed and private investors may move projects elsewhere. On the other hand, workforce development can create employment, raise income, and support broader economic activity.

2.16 Technology and Automation

Technology can reduce dependence on manual labour and improve productivity. Building information modelling supports planning and coordination. Drones, digital surveying, mobile applications, and sensors improve monitoring. Off-site manufacturing and modular construction transfer work to controlled factory environments. Robotics and automated machinery can perform repetitive or hazardous tasks.

Technology does not eliminate the need for workers. It changes the skills required and may create demand for technicians, programmers, equipment operators, and digital coordinators. Successful adoption requires investment, training, process redesign, and acceptance by employees.

2.17 Vocational Education and Apprenticeships

Vocational education and apprenticeships are essential for building the future workforce. Programs should combine classroom learning with practical site experience. Strong partnerships between employers and training providers can ensure that curricula match industry needs.

Financial support, clear career pathways, recognized qualifications, and employer participation can improve apprenticeship completion. Outreach to schools, women, minorities, veterans, and career changers can expand recruitment.

2.18 Employee Retention

Retaining workers is as important as recruiting them. Competitive pay, safe conditions, stable employment, respectful management, career progression, training, and work-life balance influence retention. Companies should understand why employees leave and respond to workforce feedback.

Mentoring, recognition, fair promotion, and supportive supervisors can strengthen commitment. Modern workforce management should treat labour as a long-term capability rather than a temporary project input.

Research Methodology

3.1 Research Design

The study uses a qualitative research design based on secondary data. This approach is appropriate because the research examines existing knowledge, industry reports, academic studies, and policy discussions related to construction labour shortages. It allows the identification of common causes, impacts, and recommendations across different contexts.

3.2 Data Collection

Secondary data were collected from journal articles, books, government reports, industry publications, professional organizations, research papers, and credible online sources. The selected materials addressed construction employment, skills, productivity, project performance, costs, safety, training, and economic growth.

Sources were reviewed for relevance, credibility, recency, and connection to the research questions. Studies from different countries were considered to identify both common patterns and context-specific differences.

3.3 Data Analysis

Thematic analysis was used to organize and interpret the collected information. The process involved reading the sources, identifying repeated ideas, coding relevant findings, and grouping them into broader themes. The major themes included:

- Nature and extent of labour shortages.
- Ageing workforce.
- Skills and training gaps.
- Industry image and working conditions.
- Economic and migration factors.
- Productivity and project delays.
- Cost, quality, and safety impacts.
- Economic growth consequences.
- Technology and workforce-development solutions.

3.4 Reliability and Validity

Reliability and validity were supported by using multiple sources and comparing findings across studies. Priority was given to peer-reviewed articles, official statistics, recognized industry bodies, and established research organizations. Triangulation reduced dependence on a single source or

viewpoint.

3.5 Ethical Considerations

The study relied on publicly available secondary data and did not involve direct human participants. Sources were acknowledged through citations and references. Information was interpreted carefully to avoid misrepresentation.

3.6 Limitations

The study is limited by its reliance on secondary data. Labour-market conditions change over time and differ among countries, regions, and construction trades. Available reports may use different definitions and measures of shortage. The research does not provide primary survey or interview data from individual construction workers or employers.

Findings and Discussion

4.1 Extent of the Labour Shortage

The literature shows that construction employers experience difficulty filling vacancies across skilled trades, supervisory roles, engineering positions, and general labour. Shortages become more severe during periods of high demand and large infrastructure investment. Some regions face general workforce scarcity, while others primarily lack workers with specific certifications or experience.

Recruitment difficulties are reflected in longer vacancy periods, wage pressure, overtime, delayed bidding, and reduced project capacity. Small and medium-sized contractors may be particularly affected because they cannot compete with large firms on pay, benefits, or job security.

4.2 Ageing and Retirement

The ageing workforce is one of the most consistent findings. A significant share of experienced workers is approaching retirement. The industry has not recruited and trained enough replacements. This creates a loss of technical knowledge and leadership as well as a numerical shortage.

Retirement risk is especially important in specialist trades and supervisory positions. Companies need succession plans, mentoring systems, phased retirement, and knowledge-transfer practices. Older workers may continue contributing through training, planning, inspection, and advisory roles that are less physically demanding.

4.3 Weak Pipeline of New Entrants

Young people are not entering construction in sufficient numbers. Academic education is often promoted more strongly than vocational pathways. Students may have limited exposure to construction careers and may not understand the variety of roles available.

Negative perceptions of safety, physical work, temporary employment, and workplace culture discourage participation. Recruitment campaigns should show opportunities in engineering, digital construction, sustainability, management, design, advanced manufacturing, and skilled trades.

4.4 Skills Mismatch

The problem is not only the number of workers but also their skills. Employers may find applicants who lack relevant experience, certification, technical capability, or safety knowledge. Rapid technological and regulatory changes can make existing skills outdated.

Training systems must respond more quickly to industry needs. Employers should help design curricula, provide placements, supply equipment, and participate in assessment. Short courses and upskilling can help existing workers adapt to digital and sustainable construction.

4.5 Productivity Effects

Labour shortages reduce productivity through incomplete crews, overtime, fatigue, rework, and reliance on inexperienced workers. Managers may repeatedly resequence activities to work around missing trades. This creates interruptions and reduces the efficiency of labour and equipment.

The effect is not always proportional. A small shortage in a critical trade can delay a large project. Effective planning, cross-training, and subcontractor coordination can reduce but not fully remove this risk.

4.6 Project Delays

Project delays are a major consequence. Contractors may struggle to meet milestones, and dependent activities can be postponed. Delays increase overhead, finance, equipment, and administration costs. Clients may face lost revenue or delayed public benefits.

Companies may respond by extending schedules, declining projects, paying overtime, or hiring less-experienced workers. Each response has cost or quality implications. Labour availability should therefore be assessed during project planning and tendering.

4.7 Cost Escalation

Competition for scarce workers raises wages and subcontract prices. Higher labour costs can be positive for workers but challenging for project budgets. Unexpected escalation may reduce contractor margins and increase disputes over compensation.

Clients and estimators should include realistic labour assumptions and contingency. Long-term solutions should focus on productivity and workforce supply rather than suppressing wages.

4.8 Quality and Rework

Reduced experience and rushed schedules can lower work quality. Defects may arise from incorrect installation, poor finishing, inadequate supervision, or failure to follow specifications. Rework consumes additional labour and materials, worsening the shortage.

Quality management, competency verification, clear instructions, digital inspection, and experienced supervision are important controls. Apprentices should work under qualified mentors rather than being used as substitutes for fully skilled workers.

4.9 Safety

Fatigue, overtime, understaffing, and inadequate training increase safety risk. Workers under schedule pressure may bypass procedures or take unfamiliar responsibilities. Companies must avoid treating safety training as optional during labour shortages.

Improved safety can also support recruitment and retention. A strong safety culture demonstrates that the organization values employees and reduces the negative image of construction work.

4.10 Economic Effects

The shortage can delay housing, transport, energy, and public-service infrastructure. This restricts economic capacity and can increase housing costs. Construction inflation may reduce the number of projects that governments and private clients can afford.

At the same time, workforce investment has positive economic effects. Training creates employment opportunities, raises earnings, and supports local supply chains. A capable construction workforce is therefore an economic-development asset.

4.11 Role of Technology

Technology can partially offset shortages by improving planning, reducing rework, and automating selected tasks. BIM can identify clashes before construction. Off-site manufacturing can improve consistency and reduce site labour. Digital scheduling and workforce management can allocate resources more effectively.

Adoption must be realistic. Technology requires capital, skills, maintenance, and organizational change. Smaller firms may need support to access equipment and training. Workers should be involved in implementation so that technology complements rather than alienates the workforce.

4.12 Recruitment Strategies

Effective recruitment requires engagement with schools, vocational colleges, communities, and employment services. Employers can offer apprenticeships, work experience, site visits, scholarships, and clear information about earnings and career progression.

The industry should recruit from a wider population, including women, minorities, migrants, veterans, people changing careers, and workers returning to employment. Inclusive workplaces and anti-harassment policies are necessary to retain a more diverse workforce.

4.13 Retention Strategies

Retention strategies include competitive compensation, predictable schedules, safe conditions, training, recognition, supportive supervision, benefits, and promotion opportunities. Companies should reduce unnecessary turnover by improving the employee experience.

Exit interviews and workforce surveys can identify recurring problems. Good project planning also supports retention because chaotic schedules and repeated overtime contribute to burnout.

4.14 Education and Training

Governments and employers should expand vocational training and apprenticeships. Programs should reflect modern construction and include digital skills, sustainability, communication, safety, and practical competence. Financial support may help trainees complete programs.

Training should not focus only on new entrants. Existing workers need continuous professional development to use new technology and meet changing standards. Supervisory and leadership training can improve productivity and workplace culture.

Recommendations

5.1 Strengthen Apprenticeships

Construction companies should increase apprenticeship opportunities and cooperate with training providers. Programs should provide structured learning, qualified mentors, recognized credentials, and a clear path to employment. Public procurement can encourage contractors to train apprentices.

5.2 Improve Industry Image

The sector should communicate its contribution to communities, technology, sustainability, and economic development. Career campaigns should show the range of occupations and progression routes. Real employees and successful apprentices can provide credible examples.

5.3 Increase Diversity

Recruitment should target underrepresented groups. Employers must create inclusive sites, appropriate facilities, fair promotion, flexible arrangements, and zero tolerance for discrimination and harassment. Diversity can enlarge the labour pool and introduce new perspectives.

5.4 Improve Pay and Conditions

Competitive wages, benefits, stable contracts, safe workplaces, and reasonable schedules can improve recruitment and retention. Employers should avoid relying excessively on overtime. Better conditions may reduce turnover and improve productivity.

5.5 Support Training Investment

Governments can provide grants, tax incentives, training funds, and support for small firms. Employers should view training as a strategic investment. Industry-wide arrangements may reduce the fear that one firm will train workers only for competitors to hire them.

5.6 Use Technology Strategically

Companies should adopt technologies that solve clear operational problems. BIM, digital project management, prefabrication, robotics, and automated equipment can improve productivity. Implementation should include worker training, process redesign, and evaluation of results.

5.7 Workforce Planning

Contractors and governments should forecast labour demand for planned projects. Large infrastructure programs should be coordinated with training capacity and regional labour supply. Early planning can reduce competition and schedule risk.

5.8 Knowledge Transfer

Organizations should capture the knowledge of experienced workers before retirement. Mentoring, job shadowing, documentation, video instruction, and phased retirement can support transfer. Senior workers can become trainers or advisors.

5.9 Improve Migration Pathways

Where domestic supply is insufficient, well-managed migration can fill urgent shortages. Visa systems should recognize verified construction skills and protect worker rights. Migration should complement rather than replace long-term local training.

5.10 Collaboration

The problem requires collaboration among government, employers, unions, schools, colleges, professional bodies, and communities. No single organization can solve the shortage. Shared labour-market data, standards, funding, and campaigns can improve results.

Conclusion

The construction industry faces a serious labour shortage caused by an ageing workforce, insufficient new entrants, skills gaps, poor industry perceptions, changing technology, economic cycles, and migration constraints. The shortage affects productivity, project schedules, costs, quality, safety, and economic growth.

Construction projects depend on the availability of appropriate skills at the correct time. Missing workers in critical trades can delay entire projects. Reliance on overtime and inexperienced labour can increase fatigue, rework, and safety risk. Higher labour costs and reduced capacity can make housing and infrastructure more expensive.

The problem cannot be resolved through one measure. Competitive pay and good working conditions are important, but the sector also needs stronger vocational education, apprenticeships, diversity, technology, knowledge transfer, workforce planning, and collaboration. Governments should support

training and coordinate major investment programs with labour supply. Employers should improve recruitment, retention, safety, and career development.

Technology can improve productivity and reduce selected labour requirements, but it does not remove the need for a skilled workforce. Instead, it changes the skills that workers require. Investment in people and technology should therefore proceed together.

A capable construction workforce is essential for housing, infrastructure, public services, and wider economic performance. Addressing the labour shortage is not only an industry issue; it is a strategic requirement for sustainable economic and social development.

References

- Abdel-Wahab, M. S., Dainty, A. R. J., Ison, S. G., Bowen, P., & Hazlehurst, G. (2008). Trends of skills and productivity in the UK construction industry. *Engineering, Construction and Architectural Management*, 15(4), 372–382.
- Alaloul, W. S., Liew, M. S., Zawawi, N. A. W. A., & Kennedy, I. B. (2020). Industrial Revolution 4.0 in the construction industry: Challenges and opportunities for stakeholders. *Ain Shams Engineering Journal*, 11(1), 225–230.
- Arditi, D., Gluch, P., & Holmdahl, M. (2013). Managerial competencies of female and male managers in the Swedish construction industry. *Construction Management and Economics*, 31(9), 979–990.
- Barnes, M. (2019). Workforce challenges in the construction industry. Construction Industry Research and Information Association.
- Briscoe, G. (2006). How useful and reliable are construction skills forecasts? A review of the data and methodologies. *Construction Management and Economics*, 24(7), 679–688.
- Chartered Institute of Building. (2023). Construction skills and workforce report. CIOB.
- Construction. (2025). Construction labour market outlook and workforce vacancies report.
- Construction Industry Training Board. (2023). Construction skills network: Industry outlook. CITB.
- Dainty, A. R. J., Ison, S. G., & Root, D. S. (2004). Bridging the skills gap: A regionally driven strategy for resolving the construction labour market crisis. *Engineering, Construction and Architectural Management*, 11(4), 275–283.
- Dainty, A. R. J., Bagilhole, B. M., & Neale, R. H. (2000). A grounded theory of women's career underachievement in large UK construction companies. *Construction Management and Economics*, 18(2), 239–250.

De Valence, G. (2010). Innovation, procurement and construction industry development. *Australasian Journal of Construction Economics and Building*, 10(4), 50-59.

Forbes, L. H., & Ahmed, S. M. (2011). *Modern construction: Lean project delivery and integrated practices*. CRC Press.

Gambatese, J. A., Karakhan, A. A., & Rajendran, S. (2019). Workforce development and safety in construction. *Journal of Construction Engineering and Management*, 145(4), 04019011.

Goodrum, P. M., & Haas, C. T. (2004). Long-term impact of equipment technology on labor productivity in the U.S. construction industry at the activity level. *Journal of Construction Engineering and Management*, 130(1), 124-133.

Hasan, A., Baroudi, B., Elmualim, A., & Rameezdeen, R. (2018). Factors affecting construction productivity: A 30-year systematic review. *Engineering, Construction and Architectural Management*, 25(7), 916-937.

Haupt, T. C., & Harinarain, N. (2016). The image of the construction industry and its employment attractiveness. *Journal of Construction*, 9(1), 14-23.

International Labour Organization. (2022). *Skills development in the construction sector*. ILO.

Karimi, H., Taylor, T. R. B., Goodrum, P. M., & Srinivasan, C. (2018). Quantitative analysis of the impact of craft worker availability on construction project safety performance. *Construction Innovation*, 18(2), 198-214.

Loosemore, M., & Malouf, N. (2019). Safety training and positive safety attitude formation in the Australian construction industry. *Safety Science*, 113, 233-243.

McKinsey Global Institute. (2017). *Reinventing construction: A route to higher productivity*. McKinsey & Company.

Molenaar, K. R., Park, J. I., & Washington, S. (2009). Framework for measuring corporate safety culture and its impact on construction safety performance. *Journal of Construction Engineering and Management*, 135(6), 488-496.

National Center for Construction Education and Research. (2023). *Construction workforce shortages and recruitment strategies*. NCCER.

Office for National Statistics. (2023). *Construction labour market statistics*. ONS.

Oseghale, B. O., Abiola-Falemu, J. O., & Oseghale, G. E. (2015). An evaluation of skilled labour shortage in selected construction firms in Edo State, Nigeria. *American Journal of Engineering Research*, 4(1), 156-167.

- Pan, W., Gibb, A. G. F., & Dainty, A. R. J. (2008). Leading UK housebuilders' utilization of offsite construction methods. *Building Research & Information*, 36(1), 56-67.
- Perrenoud, A. J., Lines, B. C., Savicky, J., & Sullivan, K. T. (2017). Using best-value procurement to measure the impact of initial risk on project performance. *Journal of Construction Engineering and Management*, 143(5), 04017008.
- Raiden, A. B., Dainty, A. R. J., & Neale, R. H. (2004). Current barriers and possible solutions to effective project team formation and deployment within a large construction organisation. *International Journal of Project Management*, 22(4), 309-316.
- Rojas, E. M., & Aramvareekul, P. (2003). Labor productivity drivers and opportunities in the construction industry. *Journal of Management in Engineering*, 19(2), 78-82.
- Shahbazi, Y., Akbarnezhad, A., Rey, D., Ahmadian, A., & Loosemore, M. (2019). Optimization of job allocation in construction organizations to maximize workers' career development. *Journal of Construction Engineering and Management*, 145(4), 04019015.
- Shibani, A., Hasan, D., Saaifan, J., Sabboubbeh, H., Eltaip, M., Saidani, M., & Gherbal, N. (2021). Financial risk management in the construction projects. *Journal of King Saud University – Engineering Sciences*.
- Srour, I. M., Haas, C. T., & Borcharding, J. D. (2006). What does the construction industry value in its workers? *Journal of Construction Engineering and Management*, 132(10), 1053-1058.
- Watson, M. (2021). Recruitment and retention in construction trades. *Built Environment Workforce Review*, 12(3), 45-63.
- World Economic Forum. (2016). Shaping the future of construction: A breakthrough in mindset and technology. WEF.