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Article

Analysis of skilled labor shortage in the construction industry of developing countries

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Abstract: Labor productivity is an essential component for the effective execution of a project. This research aimed to determine the cause of the labor crisis in the construction industry of developing countries. This research focuses on numerous aspects such as the trades of shorted skilled labor, the shortage causes, the effects of the shortage of skilled labor in industry, the characteristics that skilled labor should have, and the mitigation strategies. The field survey conducted included twelve trades, sixteen causes, nine effects, and eleven characteristics of skilled labor. The top three trades with a significant shortage are heating, ventilation, and air conditioning (HVAC) installer technicians, wood carpenters, and glazier/aluminum workers. The top three causes accountable for the labor shortage are irregular and low wages, poor training, and economic change. Extension in the duration of the project and Errors during construction emerged as the top two effects caused by a shortage. The top three characteristics of skilled labor are technical competence, in-depth knowledge of handling tools and equipment, determination, and persistence. The survey concluded that offering advantageous wages and benefits, providing opportunities for advancement and professional development, and establishing a positive work environment can effectively reduce the effects of labor shortages by recruiting and retaining skilled individuals.

Keywords: skilled labor; productivity; labor shortage; site execution; construction management

1. Introduction

Currently, the construction industry of developing countries is facing the problem of the shortage of skilled labor [1] Pakistan is an underdeveloped country facing many problems related to the progress of projects in which labor productivity plays an important role [2] Skilled labor shortfall is the shortage of workers who can perform a specific task within a specified time, cost, and quality [3]. Delays are a worldwide challenge in the construction industry to address project failure or success [4]. A shortfall of skilled labor is a complex problem that has several consequences. Previous studies show the causes and effects of the shortfall of the workforce, but these studies have less documentation to show the relation between the shortfall and its causes [5]. Skilled labor deficiency is one significant issue distinguished in the development area, and the survey has gone through a broad review of the local construction industry [6]. From an unorganized activity, construction became a synchronized process through the new training of existing skilled workers and upgraded construction methods from where the progress and advancement of the construction industry started [7]. On the other hand, the arteries of roads are necessary to bring goods from one part of the country to other parts and even for foreign trade [8].

According to the Pakistan Economic Survey, Pakistan's construction industry accounts for 2.53% of the Gross Domestic Product (GDP). The sector employs 7.61% of the employed Pakistani labor force. Gross fixed capital formation (GFCF) in the private sector grew by 20.6% between FY2019 and FY2020 [9]. Due to its large size, the construction industry of every country has the potential to impact the economic growth of a country [8].

The Objective of construction project management is to complete a project with the client's objectives. If skilled labor falls short, the project execution will have to be delayed. An unskilled labor will be hired, whose lack of knowledge and poor quality can increase the time and cost of the project [10]. Specific skills and processes are to be employed by the project manager including project initiation, planning, execution, monitoring control, and closing [11].

While a skilled workforce can be an asset for the timely completion of a project, the project managers in the construction industry are responsible for the execution of the project in terms of cost, schedule, quality, and safety measures with overall success [12]. Learning about the types of finance can help the management to make informed decisions about capital management in construction projects [13]. Various factors affect the success of project execution in the construction industry [14]. Personnel and communication are effective in the execution of a project. The individuals involved in the project execution, the project manager, and the skilled labor are crucial for a successful project [15].

Globally and regionally, the construction industry faces persistent productivity challenges, exacerbated by skilled labor shortages [16]. Construction productivity has been flat for years while manufacturing productivity has increased two times in the meantime [17]. The construction industry has a significant share of the socioeconomic development of any country [18]. Projects often face delays due to unwanted factors resulting in various unfavorable consequences [19]. The construction industry is constantly suffering from inefficiency and low productivity due to delays caused by various factors. These delays might result in cost overruns, and litigation and even cause the discontinuation of a project [20].

Labor shortages result in widespread issues such as delays in project completion, cost overruns, and compromised quality, as seen globally and in Pakistan's construction industry. An unignorable delay factor is the domestic issues of the country [21]. The construction parties should focus on these elements to avoid or at least minimize the delay issues in construction [22]. The major factors that result in labor productivity include manpower, management, motivation, working conditions, projects, and external factors [23]. The major factors involved in labor productivity were the shortage of skilled labor, delay in payment of wages, unrealistic expectations from labor, unrealistic schedules, and lack of clarity in technical specifications [24] A labor shortage is a situation in which there is a shortfall of skilled and unskilled workers to fulfill the demand. It can affect a project in the form of poor quality of work, delays, and cost increases to correct mistakes [25].

Addressing work-life balance and mental health challenges, such as depression and anxiety, is crucial for retaining skilled labor and maintaining productivity [26]. Mental health issues are a prevailing problem for workers in almost all industries. Depression and anxiety are the most common health issues that workers have to deal

with. The continuous deterioration of mental health causes a lack of interest among the workers and causes a shortage of labor [27]. Skilled labor stands out for its specialized knowledge, technical proficiency, problem-solving abilities, and adaptability compared to unskilled or semi-skilled workers. The labor may access various education programs, apprenticeships, or hands-on training to achieve the expertise.

In comparison to unskilled or semi-skilled labor, skilled labor is stronger in problem-solving skills. They can analyze problems and come up with effective solutions to help in the smooth progression of projects and tasks. They learn and adapt quickly to the changed methodology or the modified technology. Skilled labor pays close attention to details thus ensuring quality and accuracy. They also have effective communication skills by which they can convey complex information to their colleagues, clients, and team. They pay attention to safety protocols to ensure a safe working environment and have high-quality workmanship by which they can execute the complex designs to the reality product.

The construction domain of the industry is currently facing a shortage of skilled labor. A survey by the construction industry shows us that about 75% of contractors are facing the growing problem of skilled labor shortage that is revealed in the form of cost overruns or schedule delays. In our current culture, higher education is the priority of the youngsters, and working as a construction laborer is seen as a taboo despite the bad growing circumstances. In a survey by students about attractive careers, construction was 498th out of 500 possible careers. Innovative programs and efforts should be made by construction companies to deal with this problem [28]. A skilled labor shortfall refers to a lack of workers capable of efficiently performing tasks within a specified time, cost, and quality constraints, significantly impacting economic growth and project success. Skilled labor is more productive due to specialized knowledge that helps them to perform tasks more efficiently and effectively. Countries with skilled workers are more attractive to foreign investors as such investors want to ensure that they can gain huge profits from their investments. So, they search for environments where skilled labor is available as this enhances the potential for successful business outcomes [29].

The study's goals are to evaluate the trades affected by skilled labor shortages, pinpoint the causes and effects of these shortages along with their characteristics, and create plans and solutions to deal with the issue. This methodology offered a methodical and data-driven way to comprehend workforce shortages in emerging nations' building sectors. The study provided a thorough ranking of the key elements causing the problem by fusing qualitative insights with quantitative analysis. Based on these findings, specific mitigation techniques are suggested to address the underlying causes and lessen the effects of labor shortages in the construction industry.

2. Methodology

The goal of this study's methodology was to methodically pinpoint and examine the skilled labor shortage in developing nations' building sectors. The process started with a comprehensive assessment of the literature, consulting industry, and academic sources to create a preliminary list of impacted trades and to determine the causes and

consequences of skilled labor shortages during the previous five years. Through focused group discussions [25,30–32] with subject matter experts, this preliminary list was improved to make sure it appropriately represented the state of the industry. A structured questionnaire was developed [33] based on insights from prior studies. The questionnaire aimed to capture information on trades affected by labor shortages, their causes, and their consequences. To determine the required sample size for meaningful analysis, the Kothari formula was employed, which identified the need for responses from 84 participants. However, 111 responses were collected initially, out of which 9 were excluded due to invalid or incomplete data, leaving 102 responses for analysis. Engineers, construction managers, designers, and experts working as consultants, contractors, and clients were among the survey's target respondents. Since these groups were selected due to their direct participation in building projects, their viewpoints are essential to comprehending labor shortages.

Microsoft Excel was used to enter and process survey responses. Respondents ranked different factors impacting labor shortages on a five-point Likert scale as part of the analysis. The Relative Importance Index (RII) was then used to transform the gathered data into a quantifiable metric. The RII formula is given as:

$$\text{RII} = \sum W/(H \times N) \quad (1)$$

where,

W = Weight (which was marked by the respondents ranging from 1–5 for each factor);

H = Highest value of the weight;

N = Total Respondent number.

The RII scores were used to rank trades, causes, and effects of skilled labor shortages based on their relative importance, as perceived by the respondents. The Pareto Principle (80-20 Rule) was used in the study to further simplify the analysis. This idea made it easier to concentrate on the most important transactions, factors, and outcomes that contributed to the bulk of labor shortages. For example, the survey found that the trades most impacted were HVAC technicians, wood carpenters, and glaziers/aluminum workers. Similar to this, the main causes of labor shortages were found to be low and irregular earnings, inadequate training, and economic shifts; the most prominent consequences were found to be longer project durations and construction faults.

3. Results and discussions

According to the 80-20 Rule (aka Pareto Principle) [34], HVAC Technicians, wood carpenters, and glaziers/aluminum workers are the top shortlisted trades. **Table 1** shows the RII analysis of shortened trades of skilled labor.

An HVAC technician is a skilled person who installs, maintains, and repairs heating, cooling, and ventilation systems in residential, commercial, and industrial buildings. They are trained to work with a variety of HVAC equipment, including furnaces, air conditioners, heat pumps, and ductwork. According to the research, HVAC technicians are the top shorted persons in the construction industry who cause delays in construction projects.

Table 1. RII Analysis of shorten trades of skilled labor.

Trades	*W*	RII	Mean	Rank
HVAC Installer Technicians	428	0.831068	4.15534	1
Wood Carpenters	409	0.794175	3.970874	2
Glaziers/Aluminum Workers	407	0.790291	3.951456	3
Plumbers	406	0.78835	3.941748	4
Shuttering & Folding Carpenters	405	0.786408	3.932039	5
Tile Fixers	404	0.784466	3.92233	6
MS/GI Workers	399	0.782353	3.911765	7
Steel Fixers	398	0.772816	3.864078	8
Brickwork & Plasterwork Masons	396	0.768932	3.84466	9
Electricians	392	0.761165	3.805825	10
Gypsum/Ceiling Workers	389	0.75534	3.776699	11
Painters	378	0.733981	3.669903	12

Wood carpenters, also known simply as carpenters, are skilled tradespeople who work with wood to construct, install, and repair various structures and fixtures. Carpenters work on a wide range of projects such as installing cabinets, furniture, doors, and windows, and on construction sites, where they are involved in framing, roofing, and finishing work. Carpenters typically use a variety of hand and power tools, such as saws, drills, and sanders, to cut, shape, and assemble wood components. In addition to their technical skills, carpenters work independently or as part of a construction team, and their work is essential in creating and maintaining a wide range of wooden structures in residential, commercial, and industrial projects.

Aluminum glaziers, also known as glaziers or glass installers, are skilled professionals who work with glass and aluminum to install, repair, and replace windows, doors, and other glass structures. They are responsible for measuring, cutting, and fitting glass into frames, as well as installing aluminum frames and other related materials. Aluminum glaziers typically work with a variety of tools and equipment, including glass cutters, glazing tools, and caulking guns. In addition to their technical skills, aluminum glaziers need to have a good understanding of building codes, safety regulations, and construction techniques.

According to the 80-20 Rule (aka Pareto Principle) [34], irregular and low wages, poor training, and economic changes are the top causes of the skilled labor shortage. **Table 2** shows the RII analysis of the causes of the skilled labor shortage.

Irregular and low wages refer to the inconsistent or inadequate compensation received by the workers. Irregular wages may fluctuate from one pay period to another, making it difficult for workers to predict their income. This inconsistency can create financial instability and make it challenging for individuals to budget and plan for expenses. Low wages, on the other hand, refer to compensation that is insufficient to meet the basic needs of workers and their families. Low-wage workers often struggle to afford housing, healthcare, education, and other essential expenses, leading to financial hardship. Both irregular and low wages can have a significant impact on the well-being of workers, affecting their quality of life and overall financial security. Addressing these issues often involves advocating for fair wages, implementing policies to ensure consistent and livable compensation, and supporting workers' rights.

Table 2. RII analysis of causes of skilled labor shortage.

Causes	*W*	RII	Mean	Rank
Irregular and low wages	443	0.860194	4.300971	1
Poor training	434	0.842718	4.213592	2
Economic Change	425	0.833333	4.166667	3
Lack of job security	412	0.8	4	4
Lack of interest by the youth	408	0.792233	3.961165	5
More demand in crops seasonal work	407	0.790291	3.951456	6
High Mobility to other countries	406	0.78835	3.941748	7
Not meeting employer expectation	400	0.776699	3.883495	8
Dissatisfaction with the employers	399	0.774757	3.873786	9
Low motivation	396	0.768932	3.84466	10
Small numbers of new entrants	394	0.765049	3.825243	11
Aging workforce	393	0.763107	3.815534	12
Change in skill requirements	390	0.757282	3.786408	13
Poor Image of the Construction Industry	384	0.752941	3.764706	14
New Technology	365	0.708738	3.543689	15
High education level	346	0.671845	3.359223	16

Poor training refers to a situation in which individuals receive inadequate or insufficient instruction, education, or guidance in a particular skill, profession, or area of expertise. It can occur in various settings, including workplaces, educational institutions, and vocational training programs. When individuals receive poor training, they may not acquire the necessary knowledge, skills, and competencies to perform their jobs effectively. It can lead to decreased productivity, lower quality of work, and potential safety hazards in the construction sector. Additionally, poor training can negatively impact an individual's confidence, job satisfaction, and career advancement opportunities. Addressing poor training often involves investing in comprehensive training programs. It provides ongoing support and mentorship and ensures that trainers and educators are qualified and equipped to deliver effective instruction. By addressing poor training, organizations, and educational institutions can help individuals develop the skills and knowledge needed to succeed in their roles.

Economic change means the shifts or transformations in the structure, behavior, and performance of an economy. These changes can occur due to various factors, including technological advancements, shifts in consumer preferences, changes in government policies, fluctuations in global markets, and other external influences. Economic changes can manifest in various ways, such as shifts in GDP growth, employment rates, inflation, interest rates, and trade balances. Additionally, economic change can impact industries and businesses differently, leading to shifts in market dynamics, competitive landscapes, and growth opportunities. Adapting to economic change often requires businesses, policymakers, and individuals to adjust their strategies, operations, and behaviors to remain competitive and sustainable in the evolving economic environment. It may involve investing in new technologies, retraining the workforce, diversifying product offerings, and implementing policies that support economic resilience and stability. Embracing economic change can lead to innovation, growth, and improved living standards, but it also presents challenges that require thoughtful and strategic responses.

According to the 80-20 Rule (aka Pareto Principle) [34] Increases in the duration of projects, and errors during construction are the top effects of the skilled labor shortage. **Table 3** shows the RII analysis of the effects of skilled labor shortage.

Table 3. RII analysis of effects of skilled labor shortage.

Effects	*W*	RII	Mean	Rank
Increase in the duration of project	446	0.866019	4.330097	1
Errors during construction	434	0.85098	4.254902	2
Low productivity of work	435	0.84466	4.223301	3
Improper construction method	434	0.842718	4.213592	4
Extra wastage of material	429	0.83301	4.165049	5
Inability to understand drawings	427	0.829126	4.145631	6
Poor quality of work	424	0.823301	4.116505	7
The additional cost of removing wrong work	422	0.819417	4.097087	8
Inability to manage unforeseen site problems	421	0.817476	4.087379	9

An increase in the duration of a project refers to a situation where the estimated time to complete a project extends beyond the initial schedule. An increase in project duration due to labor shortage is a common challenge in construction, manufacturing, and other industries heavily reliant on skilled labor. When insufficient workers are available to carry out the necessary tasks, the project timelines can be impacted severely. Several factors can contribute to labor shortages as discussed earlier. To address an increase in project duration due to labor shortages, project managers and organizations can consider several strategies. By adopting proactive strategies and collaborating with industry stakeholders, organizations can mitigate the impact of labor shortages on project duration and maintain productivity in the face of workforce challenges.

Errors during construction by labor can have significant repercussions on the quality, safety, and timeline of a construction project. Common errors include:

- Poor workmanship: Inaccurate measurements, shoddy craftsmanship, and improper installation of building materials can compromise the structural integrity and safety of the construction.
- Misinterpretation of plans: Failure to understand and follow construction plans and specifications can result in deviations from the intended design, leading to errors in the final structure.
- Inadequate attention to detail: Oversight of critical detailing, such as proper alignment, leveling, and adherence to building codes, can result in substandard construction.
- Lack of adherence to safety protocols: Failure to follow safety guidelines and regulations can lead to accidents, injuries, and potential legal liabilities.

By prioritizing training, quality control, and effective communication, construction projects can minimize errors caused by labor and maintain high standards of workmanship and safety.

According to the 80-20 Rule (aka Pareto Principle) [34] Technical competence, In-depth knowledge of handling tools and equipment, and determination and

persistency of work are the top characteristics of skilled labor. **Table 4** presents the RII analysis of the characteristics of skilled labor.

Table 4. RII analysis of characteristics of skilled labor.

Characteristics	*W*	RII	Mean	Rank
Technical competence	431	0.836893	4.184466	1
In−depth knowledge of handling tools and equipment	429	0.83301	4.165049	2
Determination and persistence of work	427	0.829126	4.145631	3
Communication skills	425	0.825243	4.126214	4
Ability to work in harmony with others	424	0.823301	4.116505	5
Problem−solving skills	420	0.815534	4.07767	6
Work Ethics	415	0.813725	4.068627	7
Good hand−eye and body coordination	416	0.807767	4.038835	8
Eager and willing to add to their knowledge base and skills	414	0.803883	4.019417	9
Flexibility (ease of adaptation to changes)	411	0.798058	3.990291	10
Excellent reading and analytical skills	395	0.76699	3.834951	11

The technical competence of labor refers to the skills, knowledge, and proficiency of workers in performing their specific job functions within a construction industry. It is a critical factor in ensuring the quality, efficiency, and safety of the work in various sectors, including construction, manufacturing, engineering, and technology. A strong understanding of industry-specific principles, best practices, and regulations is essential. It includes knowledge of materials, processes, standards, and safety protocols relevant to the field of work. Workers should be capable of identifying and resolving technical challenges that may arise during their work. It involves the capacity to troubleshoot issues, adapt to changing conditions, and make informed decisions to achieve desired outcomes. Compliance with industry standards, codes, and regulations is crucial. Workers should demonstrate an understanding of these requirements and adhere to them to ensure quality, safety, and legal compliance.

Having in-depth knowledge of handling tools is essential for individuals working in various industries, including construction, manufacturing, and maintenance. A comprehensive understanding of handling tools encompasses the following key aspects:

- Tool selection: Understanding the right tool for a specific task
- Proper tool usage: Knowing how to correctly and safely use each tool to achieve the desired outcome without causing damage to the tool, or workpiece
- Maintenance and care: Knowledge of how to maintain, clean, and store tools
- Safety precautions: Understanding safety protocols, including the correct use of personal protective equipment (PPE) and awareness of potential hazards
- Troubleshooting and repair: Ability to identify common tool malfunctions, perform basic repairs, and recognize signs of wear and tear.
- Efficiency and productivity: Using tools to maximize efficiency

Professionals with in-depth knowledge of handling tools are better equipped to perform tasks effectively, minimize the risk of accidents, and contribute to a safe and productive work environment. Ongoing training, certification programs, and on-the-job experience are valuable resources for individuals seeking to develop and maintain expertise in handling tools.

The determination and persistence of labor are crucial qualities that contribute to their success and effectiveness in the workplace. These characteristics are particularly important in demanding or challenging environments, where obstacles and setbacks are common. Determined and persistent workers are more likely to stay focused on their objectives, overcome obstacles, and achieve their goals.

Persistent workers are committed to delivering high-quality results. Their dedication to excellence and their willingness to invest the necessary time and effort contribute to the overall quality of their work. Determined workers are often proactive in seeking out opportunities for improvement and innovation. Their persistence drives them to explore new ideas, take calculated risks, and push boundaries to achieve better outcomes.

Employers can support and harness the determination and persistence of their workers by recognizing and rewarding these qualities, providing opportunities for professional development and growth, and fostering a supportive and inclusive work environment. Encouraging a culture that values perseverance and determination can lead to a more motivated and resilient workforce.

4. Mitigation strategies

Since HVAC Technicians, Wood carpenters, and glaziers/aluminum workers are the top shorted trades. Irregular and low wages, poor training, and economic changes are the top causes of the skilled labor shortage. Increases in the project duration and errors during construction are the top effects of the skilled labor shortage. Technical competence, in-depth knowledge of handling tools and equipment, and determination and persistency of work are the top characteristics of skilled labor.

After getting the top factors using the Pareto principle, the results were shared with the technical experts in the industry to get their expert opinions. The following mitigation strategies were found by using their expert suggestions.

The main issue of the skilled labor shortage is low wages. The wages should increase due to economic crisis and should be according to inflation so that skilled labor shows an interest in construction work. Most of the workers are doing work daily. It should be substituted with a permanent job as other professional jobs, and the salary should be monthly. There should be one month’s notice before the termination of their employment.

The government should set minimum basic wages for skilled workers based on their knowledge, qualifications, and skills. Also, frequent pay increases might motivate the workers to perform well. It will also attract more people to learn new skills. Along with the wage increment, there should be a regular check by the government personnel in the market to monitor if the labor is getting the minimum set wage of government criteria.

Skilled labor shortage can be managed by handsome wages, benefits, treated at a seniority level, and a bonus incentive policy upon completion of the task/work. More financial benefits will result in more involvement in learning skills and dedication to work.

Several training institutes are working in Pakistan to provide training and skill development, still, there is a shortage due to low quality of training since most of the

trainers are not industry-orientated. Access to these training institutes is limited, and 3 in 4 youths in Pakistan lack the skills needed for employment. The information was published by UNICEF ahead of World Youth Skills Day.

More than ¾ of the graduates have some foundational skills but no marketable skills for employment. This evidence says that the training programs are irrelevant to the skills demanded. The poor training quality can be attributed to the inefficient public administration of training programs, lack of interaction with industry, and outdated infrastructure of public institutions [35].

The shortage of skilled labor can be covered by conducting Technical Training at Grassroots levels to polish the Skills of young individuals and make them aware of the importance of quality work. Training helper-type technicians are technically sound.

Skilled Workers must provide a safe workplace for their workers and protect them against safety hazards. The government should enforce this through regular workplace inspections and investigations. An unclean work environment can reduce people's ability to concentrate. A dirty or cluttered workplace can also increase anxiety levels, affect work relationships, and affect productivity. No one wants to do work in an unhygienic environment. The pandemic has further highlighted the importance of workspace hygiene to prevent the spread of germs. So, the workplace must be clean and tidy. Poor workplace culture can include a lack of healthy competition (or a lack of motivation), lots of workplace politics, harassment by coworkers, unusually high stress, lack of recognition for achievements, or discrimination (based on ethnicity, gender, and more). If workers feel unsafe or uncomfortable, this can lead to reduced morale and productivity. Improving the workplace culture is an ongoing process. Some measures that might help include healthy competition by introducing performance-based rewards, and tackling politics at the management level.

Introducing initiatives to help workers manage stress, implementing strong policies to prevent harassment and discrimination, and creating a simple process for employees to express concerns and file complaints about any issues, it's important to remember that any efforts to improve your workplace culture start with the leadership team. A solid set of company values and a clear vision help employees feel a part of the bigger picture and thus productivity increases.

Conclusions and recommendations

This research addresses critical gaps in understanding the delays caused by the lack of productivity of a skilled workforce in the construction industry. The study identifies HVAC installer technicians, wood carpenters, and glazier/aluminum workers as the top shorted trades, whose shortages contribute to delays, time overruns, and increased costs. The primary causes of these shortages are irregular and low wages, poor training, and economic changes, while the most significant effects include project duration extensions and construction errors. Additionally, the research highlights that the top characteristics of skilled labor are technical competence, in-depth knowledge of handling tools and equipment, and determination and persistence in their work.

Future research should explore regional labor dynamics and the technological impacts on labor shortages, providing a broader understanding of these challenges. Longitudinal studies could also track the effectiveness of implemented mitigation

strategies over time. A dedicated discussion on research limitations is essential, including constraints related to the geographic and sample size, potential biases in survey responses, and external factors not considered in this study. Such additions would improve the depth and applicability of the findings, offering a clearer direction for future inquiry.

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