RESEARCH ARTICLE

Determinants of labor productivity for building projects in Pakistan

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Abstract

This study attempts to unveil and prioritize the factors affecting labor productivity in Pakistani construction industry. A triangulation strategy was adopted, comprised of a comprehensive literature review, data collection through a questionnaire survey from contractors, clients and consultants, and Delphi survey. Forty-one labor productivity factors, shortlisted through literature review, were ranked by 315 respondents based on their past experience. The relative importance index was calculated to determine the weightage of each factor. To validate the results, top fifteen factors were further analyzed using a three-round Delphi survey. The most significant labor productivity factors are identified as: shortage of skilled labor, payment delay by owner to contractor, unrealistic scheduling and expectation of labors performance, clarity of technical specification, and delay in wages payment to labor. Shortage of skilled labor remained on top in both the ranking techniques. The study has underlined certain deviations in the ranking of labor productivity factors, attained through the analysis of questionnaire survey data and Delphi analysis. The study's results are envisaged to improve the labor productivity of building projects in Pakistan in terms of the project completion time and cost. The study's findings can be generalized with care in other developing countries having similar work environment.

Keywords

Labor productivity; Stakeholders; Delphi survey; Construction industry; Pakistan

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1. Introduction

Construction industry plays an important role in the economic development of a country [1]. In addition, it provides the basis for the growth of other sectors of the economy by building the physical infrastructure needed for the production and delivery of services. According to Chitkara [2], the construction industry accounts for 6-9 percent of the Gross Domestic Product (GDP) in many countries. In Pakistan, construction industry adds

2.74 percent to the total GDP [3] and it employs 7.3% directly and 30-40% indirectly of the total labor force of Pakistan [4, p.26]. On the other hand, it is continuously facing low labor productivity, cost escalation, lacking behind from schedule and decrease in profit margins. To mitigate these problems and to enhance the profitability, many constructors are implementing the technical procedures to improve the construction labor productivity.

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Various definitions of productivity are found in the literature. It is commonly referred to as the ratio of output to input [5, 6]. In construction industry, performance ratio is generally calculated by dividing the actual productivity by baseline/expected productivity, where expected productivity can be calculated by determining the work hours and quantities installed on days when no changes or rework, disruptions or bad weather were reported [7]. Jarkas & Bitar [8] defined labor productivity as ratio of output quantity to labor hours. Thomas et al. [9] reported productivity as ratio of total output to labor, materials, equipment, energy and capital. Hanna et al. [10] indicated productivity as the ratio between total input of resources and total output of product. According to Shehata & El-Gohary [11], productivity is defined as units of work placed or produced per man-hour.

Construction labor productivity has been extensively studied in the developed countries to identify the opportunities for productivity improvement. The top most productivity improving elements on the site are the management of materials, equipment and work force [12]. Nojedehe & Nasirzadeh [13] grouped twenty-six labor productivity factors in five categories, namely: motivational factors, work condition related factors, site conditions factors, workforce related factors and project management related factors. A study conducted by Hicksona & Ellis [14] ranked the factors affecting labor productivity in Trinidad and Tobago and reported that lack of labor supervision is the most influencing labor productivity factor, followed by, unrealistic scheduling, shortage of experienced skilled labors, lack of construction management experience, delay in request for information, delay in wages payment to labor, poor communication at site, and bad weather conditions. Jamadagni & Birajdar [15] stated that the top factors affecting labor productivity are overtime, clarification of technical documentation, fatigue of labor, labor payment delay, change in order variation delay, poor communication between site management and manager, and lack of training for labors [16]. However, this study was limited to only a single

contractor and project; therefore, it cannot be generalized to the whole population due to biasness. Mahamid [17] listed the factors which negatively affect the labor productivity, such as country's political situation, shortage of equipment, insufficient and outdated equipment, lack of labor experience and poor management at sites [7].

It is difficult to enhance the productivity without improving the work performing methods. There are various techniques for measurement of total work performed; however, these techniques are not specific to an industry [18, 19]. Achieving higher productivity is the aim of each organization as it sets the foundation for cost saving [12] and plays a key role in accurate scheduling and financial success of a construction project [5]. Chaffin et al. [20] studied the laying of bricklayer and hand movement of workers with the aim to reduce all unnecessary movements. They have fixed the design of scaffold for brick masonry along with mortar box and relative height, such that the bending of worker is reduced to increase the productivity [20]. Arditi [21] identified the key problems faced on most of the building projects, including: change order variations, poor site safety plan, misplacing of tools, reworks due to errors, lack of site instructions, poor planning and workforce attitude at site.

Though it is difficult to overcome all the factors causing non-productive time, a slight improvement of 5-10% can play a major role in the competition among construction firms in terms of net profit. Likewise, an acceleration in project schedule raises the overhead charges but it ultimately reduces the project duration; thus resulting in a high profit as well as a slight improvement in labor productivity [21].

As mentioned above, various factors have been reported to impact construction labor productivity using various analysis techniques. For instance, multiple regression approach is adopted by Thomas & Raynar [22] to quantify the labor productivity factors, such as: manpower, design features-work content, environmental-site conditions, management practices-control, construction methods, and project organizational structure. In

another study [10], various statistical analyses are conducted to analyze the impact of extended overtime on construction labor, including multiple regression, p-value tests, and analysis of variance. Sonmez & Rowings [23] carried out statistical modeling for determining construction labor productivity factors. Shehata & El-Gohary [11] proposed a linear regression equation to improve construction labor productivity. On the other hand, numerous studies have conducted relative importance analyses to determine factors affecting labor productivity [6, 24]. Other modeling approaches have also been embraced by the literature to find labor productivity factors, such as artificial neural network [23, 25, 26], fuzzy expert systems [27] and principal component analysis [28].

The synthesis of the reviewed literature suggests that a large number of studies were conducted in developed countries to detect the factors causing delay and cost overrun, and to identify the labor productivity factors in highways, infrastructure and building projects. As most of these studies were conducted in the homogenous cultural contexts in developed countries, their findings cannot be exactly replicated in different regions, countries, projects and even within the same project, as it depends upon different conditions and situations [29, 30]. Few of the studies conducted in developing countries, such as Jordan [16], Oman [31] and Iran [32], have identified dissimilar labor productivity factors. Hence, similar studies need to be conducted in other developing countries and cultures, to determine whether the meaning of labor productivity, and its causes and determinants, are invariant or otherwise. According to Zahoor et al. [33], a stronger focus on the cross-cultural studies helps to explain how key labor productivity factors vary across national contexts.

In Pakistan, a large number of building projects are suffering from delay and productivity issues. Moreover, there are no specific statistics available to gauge the labor productivity. Motivated by this research gap, the present study seeks to address this literature shortcoming and attempts to identify and

rank the significant factors affecting the labor productivity on building projects in Pakistan. The significance of the study lies in prioritizing the significant labor productivity factors for Pakistani construction industry. Though this study is limited to the representative consultants, contractors and clients working on building projects in Pakistan, its results can only be replicated in the regions having similar work environment.

2. Methodology

2.1. Research method

The manual of research methods defines five styles of research in the area of construction engineering and management, including: experiment, survey, action research, ethnographic research and case study [34]. However, the most widely used methods are experiments, surveys and case studies. Driven by the cost and controllability issues of experiments, time consumption is an important factor limiting the use of experiments in the construction industry. Similarly, case studies suffer from generalization problem as the results from one company are practically very different from other companies. Thus, questionnaire survey is adopted by almost all research studies to obtain the standard dataset. Surveys are also the most widely used and accepted method of data collection in social sciences research. Moreover, surveys are found to be cost-effective [33] and provide valuable data which cannot be directly measured, such as attitudes, casual relationship and behavior. Furthermore, surveys have proven to be valuable as they provide an insight and can be used to develop a strong statistical association between key variables [34].

This research was carried out in a systematic way to achieve the study's objectives. A triangulation strategy was adopted [35] comprised of: (1) conducting a comprehensive literature review to identify the forty-one labor productivity factors, (2) ranking of the identified factors, based on the analysis of data (N=315) collected through a questionnaire survey from contractors, clients and consultants, and having work experience of

building projects in Pakistan, and (3) validation of the ranking through a three-round Delphi survey from 24 industry's experts. Random sampling was carried out to collect the data using questionnaire survey, as it offers ease of gathering data from a relatively small representative sample to infer for the whole population. It also mitigates the researcher and respondent biases and enhances the study's reliability [33].

2.2. Questionnaire design

The survey design process for this study is shown in Fig. 1. A thorough literature suggested that a variety of factors exist affecting labor productivity. However, for this study, only significant labor productivity factors (41), clustered into five main productivity groups, were shortlisted through a comprehensive literature review [12, 14, 15, 32, 36, 37], as shown in Table 1. Considering exhaustive and the entire range of factors was beyond the scope of this study.

It was followed by the analysis of data collected from 315 respondents using a questionnaire survey. In the first part of the survey questionnaire, general information was asked using multiple choice questions, such as age, working experience, qualification, and the classification of respondents

into contractor, consultants and clients. In the second part, respondents were asked to mark the significance of forty-one labor productivity factors on a five-point Likert scale ranging from 1 (very low effect) to 5 (very high effect) [1, 33]. These factors were then ranked based on the relative importance index (RII).

2.3. Pilot study

The pilot study was aimed at improving the questionnaire's format, layout, the wording of questions and the overall content of the survey. Hence, a two-step pilot study was carried out which helped in ensuring the clarity of questions, removing ambiguities, and relevance to a specific group of people. In the first step, questionnaire was sent to 5 industry and academic experts, and their constructive comments were addressed. The amended questionnaire was again shared with two contractors, consultants and clients, who were not the part of final survey program. The feedback obtained from these people helped in improving/removing anomalies and discrepancies and final questionnaire was prepared by addressing their feedback.

Fig. 1. Survey design process

Table 1. Labor productivity factors identified through literature review

Group	Labor Productivity Factor	Reference	RII
Human / labor related factors (<i>RII=0.612</i>)	Shortage of skilled labor	[38], [39]	0.81
	Delay in wages payment to labors	[14], [40]	0.67
	Communication problems between site management & labors	[41], [42]	0.63
	Lack of labor training	[43]	0.63
	Motivation of labors	[41], [44]	0.67
	Lack of periodic meeting with crew members	[44]	0.53
	Lack of incentives schemes for labors	[41], [45]	0.58
	Influence from other crew members	[46], [47]	0.65
	Physical fatigue of labors	[20], [41], [48]	0.76
	Lack of transport facilities to labor	[13], [49]	0.51
	Lack of suitable rest area at site	[41]	0.64
	Unclear instruction to labor	[41], [42]	0.52
	High absenteeism of labor	[13], [50]	0.59
	Labor strike	[50]	0.64
Management related factors (<i>RII=0.655</i>)	Delay in payment	[40], [51], [52]	0.58
	Lack of labor supervision	[53]	0.60
	Working overtime	[22], [53]	0.76
	Construction managers lack of experience	[13], [42]	0.56
	Proportion of work subcontracted	[9]	0.71
	Unrealistic scheduling and expectation of labors performance	[54], [55]	0.71
	Crew size and composition	[40]	0.61
	Unsuitability of storage location	[56]	0.52
	Shortage of materials	[13], [57]	0.61
	Accidents as a result of poor site safety plans	[58]	0.63
Technology related factors (<i>RII=0.648</i>)	Clarity of technical specification	[59], [60]	0.70
	Inspection delay by the engineer	[42]	0.54
	Rework due to errors	[13], [24], [42]	0.70
	Coordination level among design disciplines	[42]	0.53
	Design complexity level	[61]	0.52
	The extent of variation/ Change order during execution	[41], [56], [62]	0.62
	Site layout	[42]	0.73
	Effect of poor project definition	[32]	0.62
	Impact of changes in the economic and political environments	[56]	0.51
	Delay in responding to request for information	[22]	0.52
Financial factors (<i>RII=0.697</i>)	Payment delay by owner to contractor	[40], [51], [52]	0.73
	Labor low wages	[14], [40]	0.56
	Financial condition of contractor	[63]	0.54
	Lack of financial motivation system	[52]	0.59
External (environment / weather) factors (<i>RII=0.619</i>)	Low/High temperature	[64], [65]	0.69
	Inclement weather / Rain	[65]	0.60
	High humidity	[65]	0.51

Note: RII represents relative importance index, and its values are calculated based on the analysis of questionnaire survey data.

2.4. Sample selection

The accurate sample size is significant for reliable data analysis. It ensures that the data is a true representative of the target population. The target population for this study comprised of clients, contractors and consultants. As per the valid registration with Pakistan Engineering Council, the numbers of registered contractors were 32,720, in 2015. Total number of town planners, architects and consultants were 1,488. The numbers of clients registered with Public Procurement Regulatory Authority (PPRA) were 640. Hence, the total population was 34848. The sample, representing the true population, was calculated by the using Eq. (1) and (2) [66, 67], with a precision level of $\pm 5\%$, where 95% of the sample size comes within 2 standard deviations.

$$n = \frac{n'}{[1 + (\frac{n'}{N})]} \quad (1)$$

$$n' = \frac{(p \times q)}{e^2} \quad (2)$$

Where, n = Sample size from finite population, n' = Sample size from infinite population, N = Population size, p = Proportion of the characteristic being measured in the target population, $q = 1 - p$, and e = Standard error of sampling population which is equal to 0.05 for 95% confidence interval. In order to achieve maximum sample size, values of p and q were taken as 0.5. By using Eq. (1), the sample size obtained for clients, consultants, and contractors were 86, 94, and 100.

2.5. Data collection and survey response

The questionnaire was distributed using soft copy (email) as well as a hard copy (personal meetings and interviews). Most of the respondents were met physically on building projects. The respondents, in this way, had a distinct advantage of inquiring about any difficulty occurring in filling the questionnaire. It also helped in achieving a higher response rate. The project engineers, contractors, consultants and project managers, working at various building projects in four provinces i.e. Khyber Pakhtunkhwa (KPK), Sindh, Punjab and Baluchistan, were visited personally to get their feedback on the questionnaire.

At most of the construction sites, respondents were briefed about the significance of this survey, and requested to fill in the questionnaire honestly. However, at some of the construction sites, project managers and their supervisors were briefed to further explain to their employees the importance and intended benefits of this survey. The respondents were guaranteed (verbally and in writing) about the confidentiality of their responses, and they were at liberty to decline the questionnaire filling request and not disclose their identity.

Of the 510 distributed questionnaires, 321 filled questionnaires were received with a response rate of over 61%. After the imputation of missing values and deletion of 6 incomplete and unengaged responses [33], 315 questionnaires were accepted for analysis. The summary of survey responses, mentioning the respondents' types vis-à-vis their location, is presented in Table 2.

Table 2. Summary of survey response and data collection

Location	Contractor		Consultants		Clients/ P. Managers		Total Sent	Total Received
	Sent	Rec*	Sent	Rec*	Sent	Rec*		
KPK	130	72	86	76	89	48	245	196
Punjab	42	28	22	16	47	28	158	72
Sindh	29	14	8	3	14	8	78	25
Baluchistan	19	10	06	1	18	11	29	22
Total	220	124	122	96	168	95	510	315
	56.36 %		78.69 %		56.55 %		61.76 %	

*Received

2.6. Data analysis techniques

RII was calculated using Eq. (3) to rank the identified labor productivity factors [6, 8, 68].

$$RII = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1}{5(n_1 + n_2 + n_3 + n_4 + n_5)} \quad (3)$$

Where, RII is the weightage given to each factor by the respondents; n_1, n_2, n_3, n_4, n_5 are the number of respondents who selected (1) very low effect, (2) low effect, (3) moderate effect, (4) high effect and (5) very high effect, on a five-point Likert scale. To validate the results/ranking, top fifteen labor productivity factors were further analyzed and ranked using a three-round Delphi survey.

2.7. Delphi survey

The Delphi method is an iterative process and generally used when the researcher is trying to obtain the better understanding of the problem and to create a prediction or estimate a potential solution to the complex problem [69]. It is a structured communication technique used to get the opinion of experts without any conversation between them. This method is widely used for social sciences as a tool when complete knowledge about the issue or problem / phenomenon is missing. Usually, it is completed in two or more rounds. The experience and the organization of respondents guarantee the reliability of their feedback. Hence, the panel should preferably be a heterogeneous group enriched by diversified experiences [35]. The panel size is advised to be having a minimum of seven members [70], which can be increased up to 50 [71, p. 160].

For this study, top 15 labor productivity factors, initially ranked using RII, were analyzed using a three-round Delphi survey from 24 industry experts representing consultants, contractors and clients. Criteria devised to select the potential respondents included: having a minimum of four years' experience working on building projects as construction/project manager or site engineer; and a registered member of the

Pakistan Engineering Council either as an engineer, consultant or a contractor. The experts were asked to rank each factor based on its impact on the productivity. After each round, the average mean value of each factor was calculated, and shared again with all the experts, giving them the option to either maintain or revise their earlier answers, with respect to the replies of other members of their panel. A consensus was, finally, achieved among the experts after three rounds of Delphi survey.

3. Data analysis and results

3.1. Characteristics of respondents

Summary of personal attributes of respondents is presented in Table 3. Half of the respondents (50%) possessed working experience between 5 to 10 years. The majority of respondents (39%) were contractors and most of the respondents were aged between 25-30 years. Moreover, 46% of respondents were holding a graduate degree. The proportions of respondents according to their working level is project managers (12.06%), construction managers (13.33%), site engineers (27.62%) and site supervisors/foremen (46.98%).

3.2. Reliability analysis

The test to investigate the normality of data is a precursor to any statistical analysis such as reliability or regression and can be assessed either numerically or graphically. Significance level (α) of 0.05 is used in this study for hypothesis testing. The hypothesis for this study is framed as:

- Null Hypothesis (H_0): The population means are equal, i.e. $\mu_1 = \mu_2$
- Alternative Hypothesis (H_a): the population means are not equal, i.e. $\mu_1 \neq \mu_2$

The independent t-test shows that the data are distributed normally and the reliability test can be applied to the data to check its reliability. The reliability test defines the reliability of a questionnaire to test it across different locations and populations [72], and it can be measured using Cronbach's coefficient alpha [72].

Table 3. Summary of personal characteristics of respondents

Characteristics	Number of Respondents	Percentage
<i>Working Experience</i>		
Less than 5 year	69	21.90 %
5-10 year	158	50.16 %
10 and above	88	27.94 %
<i>Category/Classification</i>		
Contractor	124	39.37 %
Consultant	96	30.48 %
Client	95	30.16 %
<i>Working Level</i>		
Project Manager	38	12.06 %
Construction Manager	42	13.33 %
Site Engineer	87	27.62 %
Site Supervisor/Foreman	148	46.98 %
<i>Age (in years)</i>		
Less than 25	32	10.16 %
25-30	138	43.81 %
31-35	95	30.16 %
More than 35	50	15.87 %
<i>Educational Qualification</i>		
Under Graduate	107	33.97 %
Graduate	145	46.03 %
Post Graduate	63	20.00 %

The Cronbach's alpha ranges from 0 (unreliable) to 1 (reliable). The value of Cronbach's coefficient alpha was calculated as 0.82 which shows that the data is reliable [1].

3.3. Ranking of the identified labor productivity factors

The perceived effect of all the forty-one labor productivity factors was calculated based on the analysis of questionnaire survey data. Table 1 displays the RII values of all the factors and their corresponding groups. The factors significantly influencing the labor productivity, in descending order, were identified as: shortage of skilled labor (RII=0.81), physical fatigue of labors (RII=0.76), working overtime (RII=0.76), site layout

(RII=0.73), and payment delay by owner to the contractor (RII=0.73). While the least essential factors were identified as: high humidity (RII=0.51), impact of changes in the economic and political environments (RII=0.51), lack of transport facilities to labor (RII=0.51), delay in responding to request for information (RII=0.52), design complexity level (RII=0.52), and unsuitability of storage location (RII=0.52).

These factors were also clustered into five main productivity groups based on the literature review: human related factors, management related factors, financial related factors, technological factors, and environment related factors [73]. The descriptive statistics of these productivity groups are tabulated in Table 4.

Table 4. Descriptive statistics of the five productivity groups

Factor	Human factors	Management factors	Technical Factors	Financial Factors	External Factors
Mean	3.061	3.276	3.240	3.484	3.097
Median	3.071	3.300	3.200	3.500	3.000
Mode	3.000	3.500	3.200	3.500	3.000
Std. Dev	0.398	0.419	0.483	0.545	0.686
Variance	0.157	0.175	0.234	0.297	0.471

Although, a small difference is observed in the significance of economic and socio-psychological factors in a past study [74], the results of this study indicate that the mean, standard deviation and variance for ‘human / labor related factors’ were found to be relatively less than other four productivity groups. This implies that little attention is being paid to human / labor related factors, such as: lack of periodic meeting with crew members (RII=0.53), unclear instruction to labors (RII=0.52), and lack of transport facilities to labor (RII=0.51).

3.4. Delphi analysis

To validate the ranking of labor productivity factors, obtained through the analysis of questionnaire survey data, a Delphi survey was conducted. It helped to develop a consensus in the opinion of industry’s experts after three rounds. The Delphi survey questionnaire, comprised of top 15 labor productivity factors, was distributed to 45 experts of the construction industry through emails. However, only 24 responses were obtained. The average mean results for each factor are presented in Fig. 2. The shortage of skilled labor again emerged as the most significant factor (RII=0.83), whereas the factor of ‘influence from other crew members’ (RII=0.62) achieved the lowest ranking.

3.5. Comparison of the results obtained through questionnaire survey and Delphi survey

A comparison of the ranking of top 15 labor productivity factors, obtained through the analysis of survey data and Delphi analysis is presented in Table 5. It is of note that few of factors obtained a higher value/ranking after

conducting Delphi analysis, while some of the factors achieved a lower ranking. Likewise, four least important factors remained in the bottom, in both types of analyses. This fact is highlighted with upward (↑) and downward (↓) arrows in Table 5.

4. Discussion

This study has investigated the factor affecting labor productivity for building projects in Pakistan. The forty-one significant labor productivity factors, identified through a comprehensive literature review, were clustered into five groups, namely human, management, technology, finance, and weather related factors. The finance related factors attained the highest RII and mean value among these productivity groups. This is in line with the findings of Kazaz & Ulubeyli, in which monetary factors are found to be dominantly influencing the labor productivity in the construction industry of Turkey [74].

The study has also identified the most significant and least influential labor productivity factors through the analysis of questionnaire survey data. The top fifteen labor productivity factors were further analyzed using a three-round Delphi survey. It resulted in some deviations in the ranking obtained after the analysis of questionnaire survey data, as shown in Table 5. The variations observed in the ranking could possibly be due to the respondents’ bias, as the survey data was collected from a larger sample (N=315) comprised of all types of respondents, while the respondents of Delphi survey were more experienced and less in number.

Fig. 2. Ranking of the significant labor productivity factors based on Delphi analysis

Table 5. Comparison of the results obtained through the analysis of questionnaire survey data and Delphi analysis (*Top 15 labor productivity factors only*)

Questionnaire Survey Feedback	RII**	Delphi Survey Feedback	RII®
Shortage of skilled labor	0.81	Shortage of skilled labor ↑	0.83
Physical fatigue of labors	0.76	Payment delay by owner to contractor ↑	0.81
Working overtime	0.76	Unrealistic scheduling and expectation of labors performance ↑	0.77
Site layout	0.73	Clarity of technical specification ↑	0.76
Payment delay by owner to contractor	0.73	Delay in wages payment to labors ↑	0.73
Proportion of work subcontracted	0.71	Proportion of work subcontracted	0.71
Unrealistic scheduling and expectation of labors performance	0.71	Physical fatigue of labors ↓	0.71
Clarity of technical specification	0.70	Rework due to errors ↑	0.71
Rework due to errors	0.70	Working overtime ↓	0.68
Low/High temperature	0.69	Site layout ↓	0.68
Delay in wages payment to labors	0.67	Low/High temperature ↓	0.67
Motivation of labors	0.67	Motivation of labors	0.67
Influence from other crew members	0.65	Lack of suitable rest area at site ↑	0.66
Lack of suitable rest area at site	0.64	Labor strike ↑	0.65
Labor strike	0.64	Influence from other crew members ↓	0.62

Note: RII** values are calculated based on the analysis of questionnaire survey data, while RII® values are calculated based on the Delphi analysis.

↑represents an increase in the ranking of labor productivity factor after Delphi analysis, while ↓represents a decrease in ranking of labor productivity factor after Delphi analysis.

For that reason, the ranking obtained through Delphi analysis can be considered more reliable as a consensus was achieved in the opinion of experts after three rounds of Delphi analysis.

The most significant labor productivity factors, in descending order, are identified as: shortage of skilled labor (RII=0.83), payment delay by owner to contractor (RII=0.81, unrealistic scheduling and expectation of labors performance (RII=0.77), clarity of technical specification (RII=0.76), and delay in wages payment to labors (RII=0.73). The factors which are given lowest ranking by the industry's experts include: motivation of labors (RII=0.67), lack of suitable rest area at site (RII=0.66), labor strike (RII=0.65), and influence from other crew members (RII=0.62). A focus on these factors can help the key stakeholders to considerably enhance the construction productivity.

It is a common perception that less amount of instruction is required for more skilled and experienced labors [75]. The loss of such workers is mostly due to short-term projects as every laborer would try to achieve employment in projects having a long duration. To maintain the skilled labor staff, it is necessary to provide job security to such labor force; otherwise, it will negatively impact the labor productivity [75]. Further, the 'payment delay by owner to contractor' is identified as the 2nd largest factor affecting labor productivity [6, 76]. Most of the companies lost their experienced and skilled labors due to late payment from the owner. The new work force not only requires training and time, but results in productivity loss. This judgment is in line with the findings of a survey-based study [77], conducted in a developing country, in which "on-time payment" was ranked third among thirty-seven labor productivity factors. In addition, they have identified the quality of site management and material management as the most important factors, for which experienced and skilled manpower is essentially required.

'Unrealistic scheduling and expectation of labors performance' is identified as the 3rd most

influential labor productivity factor. It has been highlighted in many researches that working 7 days a week, and for a period of more than 8 hours a day, are becoming the major source of a decline in labor productivity [10, 78, 79]. Thus avoiding the 'unrealistic scheduling' is the easy way to enhance labor productivity. It must be given due consideration at the planning stage of a project.

'Clarity in technical specifications' has emerged as the 4th most important labor productivity factor. It is in line with the findings of Jarkas et al. [31] conducted in Oman. Färe et al. [80] has also emphasized to avoid vague technical specification and incomplete drawings to achieve a higher productivity level. The 5th most significant factor i.e. delay in wages payment to labors, is somehow similar to the 2nd most significant factor i.e. payment delay by owner to contractor. This implies that a delay in payment, at all levels, is detrimental to the productivity.

The factors of 'proportion of work subcontracted' and 'physical fatigue of labors' also influence the labor productivity significantly. Jamadagni & Birajdar [15] have also suggested reducing the labors fatigue to enhance their productivity. Another important factor influencing the labor productivity is 'rework due to errors' [31, 81]. It mostly occurs due to the poor workmanship and variations in the design. Besides poor working methods, the shortage of experienced labor is becoming the major cause of rework in today's construction industry [16]. The rework results in changing the original schedule and leads to material loss and cost overrun.

Loss of labor productivity due to 'working overtime' is in line with past studies [7, 10, 78, 79]. Overtime results in fatigue, poor workmanship, accidents, higher absence, and all these factors negatively impact the labor productivity [7]. The tight schedules of the contractors to complete the project ends up in project acceleration and an increase in working hours.

Similarly, the 'site layout' should be ensured through effective housekeeping at construction

site. The site should be designed in such a way that labors face less effects of 'extreme weather conditions', as the extreme weather conditions negatively influence the labor productivity [82]. Project managers during the planning stage need to keep suitable flexibility in the schedule to cater for weather effects. There is also a need to motivate the labors for enhancing their productivity [83]. The motivation can be increased by providing timely salary to the crew and giving incentives. The relation between management and the working staff, job security, and the incentives like provision of premium and bonuses, are the key points to encourage the labor staff [16, 75]. It would also help to stop the workers to go for strike.

The findings of the study can help the key construction stakeholders, including project owners and construction firms, to plan their future works with a greater focus on the most significant labor productivity factors. The study would also help international constructors to plan their projects in Pakistan by making an allowance for the country-specific factors.

5. Conclusions

This study has identified and ranked the labor productivity factors for building projects in Pakistan. The adopted methodology comprised of a triangulation strategy including literature review, questionnaire survey, and a three-round Delphi survey. Based on the views of construction professionals and industry experts, the study has ranked 15 most significant factors affecting the labor productivity. To achieve an enhanced productivity level, key construction stakeholders need to focus on the most significant factors, including: shortage of skilled labor, payment delay by owner to contractor, unrealistic scheduling and expectation of labors performance, clarity of technical specification, and delay in wages payment to labors. The study has also identified the factors having less influence on labor productivity, including: high humidity, impact of changes in the economic and political environments, lack of transport facilities

to labor, delay in responding to request for information, design complexity level, and unsuitability of storage location. The study results are envisaged to improve the labor productivity of building projects in Pakistan in terms of the project completion time and cost. Moreover, the results can be generalized cautiously in other developing countries sharing a similar work environment and economic conditions, such as Ghana, Thailand, and also at the regional level like India, Bangladesh, Nepal and Sri Lanka. Future studies may conduct a similar survey to measure the perception of labors, foreman, and subcontractors.

Ethics committee permit and/or legal/special permission

The author(s) confirm that no ethics committee permit is necessary for data collection via questionnaire, but special permissions have been obtained from the company owners to fill in the questionnaire of their employees.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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