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Factors Influencing Construction Labour Productivity: An Indian Case Study

*Anu V. Thomas and J. Sudhakumar

Abstract: Construction productivity is of interest to researchers and practitioners because of its impact on the performance of construction projects. Despite various studies to identify factors influencing productivity in other countries, no study has addressed productivity issues in India. This paper reports the results of a questionnaire survey of project managers, site engineers, supervisors and craftsmen, in the state of Kerala in India, to identify the factors influencing construction labour productivity. The top five factors identified as having a significant impact on productivity: (1) timely availability of materials at the worksite, (2) delayed material delivery by the supplier, (3) strikes called by political parties or hartals, (4) frequent revisions of drawings/design, resulting in additional work/rework and (5) timely availability of drawings at the worksite. The findings provide a better understanding of the factors influencing productivity in the Indian context and will aid construction practitioners in making effective plans for productivity improvement.

Keywords: Construction, Labour productivity, Factors, Severity index, India

INTRODUCTION

Construction is the world's largest and most challenging industry (Tucker, 1986). The output of the construction industry constitutes one half of the gross capital and is 3 to 8% of the Gross Domestic Product (GDP) in most countries (Arditi and Mochtar, 2000). Nevertheless, poor performance of the industry has been a cause of great concern among practitioners and academics. Construction projects worldwide have been experiencing significant cost and time overruns, with low labour productivity identified as a major reason for project delays and cost overruns. Improvement of construction labour productivity is therefore critical.

The construction industry in India contributes to over 5% of the nation's GDP and employs over 30 million people (Planning Commission, 2008). The contribution of the industry to the economy and employment is expected to grow significantly in the forthcoming years. However, the industry is plagued by cost and time overruns. Doloi et al. (2012) have identified poor labour productivity as a major reason for delays in Indian construction projects. Despite the importance of productivity in the performance of construction projects, labour productivity is rarely measured at Indian construction sites; hence, productivity losses are never recognised. The current scenario of the Indian construction industry thereby warrants research in construction labour productivity, particularly in identifying opportunities for construction productivity improvement.

The first step in improving construction productivity is to identify the influencing factors (Mojahed and Aghazadeh, 2008; Rivas et al., 2011). After productivity factors are identified, management can take actions to mitigate these issues. There have been several studies to identify labour productivity factors in other countries. However, there has been no effort in identifying factors

Department of Civil Engineering, National Institute of Technology Calicut, Kerala, INDIA
*Corresponding author: anuthomastkmce@gmail.com

influencing construction labour productivity in the Indian context. Researchers maintain that the major productivity factors vary from country to country, place to place and project to project (Jarkas and Bitar, 2012; Mojahed and Aghazadeh, 2008). The productivity factors identified by researchers in other countries may not be relevant in the Indian scenario due to the different social, political and economic environment in India. Therefore, the objective of this research is to identify and rank factors influencing productivity that are applicable to the Indian construction industry. To achieve this objective, a questionnaire survey of project managers, site engineers, supervisors and craftsmen working on construction sites in the state of Kerala in India was conducted. The rationale behind obtaining the responses from all project participants was to understand the differences in their perceptions of factors influencing productivity.

LITERATURE REVIEW

Productivity is commonly referred to as the ratio of output to input. Sumanth (1984) defined productivity as the effective utilisation of resources (inputs) in producing goods and/or services (output). Two measures of productivity are commonly used in the construction industry (Jarkas and Bitar, 2012). The first measure of productivity is the total factor productivity (TFP), which is defined as the ratio of total output to total input, with the latter usually including labour, materials, equipment, energy and capital. TFP is expressed as shown in Equation 1:

$$TFP = \frac{Total\ output}{\sum(labour + materials + equipment + energy + capital)} \quad \text{Eq. 1}$$

The second measure of productivity is the partial factor productivity (PFP), which is expressed as the ratio of the outputs to a single or selected set of inputs. One of the most commonly used PFP measures in construction is labour productivity, which is defined as the ratio of output to labour input; the output is measured in terms of the quantities installed, and labour input is measured as work-hours. Thus, labour productivity is expressed as follows:

$$Labour\ productivity = \frac{Output\ quantity}{Labour\ hours} \quad \text{Eq. 2}$$

The data for computations of the total factor productivity are relatively difficult to obtain, but the measurement process becomes much easier and more controllable when a partial factor measure such as labour productivity is used (Jarkas and Bitar, 2012). Construction is a labour-intensive industry, and labour is the most flexible resource available to the management; thus, the focus on construction labour productivity is clearly justified.

Construction labour productivity has been extensively studied by researchers to identify opportunities for productivity improvement. In the USA, Borcherding and Garner (1981) used questionnaire surveys and interviews to identify and rank factors influencing construction labour productivity. The major problems influencing productivity that emerged in the study were material

availability, tool availability, rework, overcrowded work areas and inspection delays.

Alinaitwe, Mwakali and Hansson (2007), Enshassi et al. (2007), Jarkas and Bitar (2012), Kadir et al. (2005), Kaming et al. (1997), Makulsawatudom, Emsley and Sinthawanarong (2004), Mojahed and Aghazadeh (2008), Olomolaiye (1988) and Rivas et al. (2011) have also conducted similar surveys in various parts of the world. The ranking of the productivity-influencing factors observed in the various studies are presented in Table 1. The ranking of the factors is based on different indices and involved different categories of respondents, including craftsmen, supervisors, contractors, project managers, consultants and developers.

As shown in Table 1, the majority of the studies identified material-related problems among the most significant factors impacting productivity. However, in Kuwait, material problems were not discerned to have a decisive effect on productivity, mainly due to the financial strength of local contractors and the availability of materials locally or by direct imports (Jarkas and Bitar, 2012). The study in Uganda rated the factors affecting construction productivity with respect to time, cost and quality, and, although material shortage was ranked first with respect to time, it was rated only seventeenth based on the overall importance index and hence does not appear among the critical factors (Alinaitwe, Mwakali and Hansson, 2007). Other factors that were deemed important in the previous studies are lack of tools and equipment, rework, incompetent supervisors, lack of labour supervision, lack of skills and experience of the workforce, design/drawing alterations and interference. Though similarities exist, the major productivity factors vary from country to country, necessitating research into productivity factors relevant to a particular region.

Chan and Kaka (2007) administered a questionnaire survey in the United Kingdom to understand the difference in perception among project managers and construction workers of factors affecting construction labour productivity. The white collar sample ranked supervision, simplicity of building design, level of site experience, information flow and communication with sub-contractors as the top five factors. However, quality requirements, health and safety management, communication within gangs, utilisation of plant and health and safety and Construction Design and Management (CDM) were considered important by blue collar workers. This study provided insight into factors important to the two groups and emphasised the need for integrating the differences in opinion between the two groups to achieve productivity improvement.

Except for the studies in the UK and Chile (Chan and Kaka, 2007; Rivas et al., 2011), the productivity factors identified in the previous research efforts were from the perspective of one of the project participants, with no attempt to understand the difference in perception among the project participants on factors influencing productivity. The study in the UK did not capture the perception of the supervisors (Chan and Kaka, 2007), while the opinion of the project managers was not sought in the Chilean study (Rivas et al., 2011). An understanding of the relative importance of productivity factors from the perspective of various project participants is essential to make effective plans for productivity improvement. In this study, therefore, the input of all project participants (project managers, site engineers, supervisors and craftsmen) has been sought to identify problems impacting productivity.

Table 1. Ranking of Factors Influencing Labour Productivity in Previous Studies

Author/ Authors	Country	Questionnaire Respondents	Ranking of Factors in Various Studies				
			1	2	3	4	5
Borcherding and Garner (1981)	USA	Craftsmen	Material availability	Tool availability	Redoing work	Overcrowded work areas	Inspection delays
Olomolaiye (1988)	UK	Bricklayers	Lack of materials	Gang interference	Repeat work	Supervision	Lack of equipment
Kaming et al. (1997)	Indonesia	Craftsmen	Lack of material	Rework	Absenteeism	Interference	Lack of tools
Makulsawatudom, Emsley and Sinthawanarong (2004)	Thailand	Project managers	Lack of material	Incomplete drawing	Incompetent supervisors	Lack of tools and equipment	Absenteeism
Kadir et al. (2005)	Malaysia	Contractors, developers and consultants	Material shortage at project site	Non–payment to suppliers causing stoppage of material delivery to site	Late issuance of progress payment by client to main contractor	Lack of foreign and local workers in the market	Incapability of site management to organise site activities
Alinaitwe, Mwakali and Hansson (2007)	Uganda	Project managers of building contractors	Incompetent supervisors	Lack of skills of the workers	Rework	Lack of tools/ equipment	Poor construction methods
Enshassi et al. (2007)	Gaza strip	Contractors	Material shortages	Lack of labour experience	Lack of labour surveillance	Misunderstandings between labour and superintendents	Drawings and specification alteration during execution
Mojahed and Aghazadeh (2008)	Deep south USA	Construction contractors	Skills and experience of workforce	Management	Job planning	Motivation	Material availability
Rivas et al.(2011)	Chile	Direct workers and mid–level employees	Materials	Tools	Equipment and trucks, rework	Absenteeism	–
Jarkas and Bitar (2012)	Kuwait	Contractors	Clarity of technical specifications	The extent of variation/ change orders during execution	Coordination level among various design disciplines	Lack of labour supervision	Proportion of work subcontracted

RESEARCH METHOD

Survey Questionnaire

A detailed review of the literature revealed a number of factors affecting construction labour productivity. Discussions were held with construction practitioners working on project sites to identify factors influencing labour productivity in Kerala. The interviews with construction personnel sought input into the relevance of factors identified from the literature in the context of the state and attempted to identify factors unique to the state. The construction professionals revealed political strikes or hartals to be a persistent problem severely impacting labour productivity in the state. Another factor that evolved during discussions with the practitioners was unsafe working conditions and total negligence to safety precautions on construction sites. Lack of periodic meetings to monitor project progress was also recognised by the respondents as a factor affecting productivity. Kerala has been experiencing an influx of construction labourers from other parts of the country in recent times, and the practitioners noted communication problems with the labourers, speaking different languages, as an issue influencing productivity. In addition to these factors, other factors relating to project management inefficiencies, site conditions, craftsmen and supervisor characteristics, material problems, drawing and design issues, tool and equipment issues, craftsmen motivational issues and weather, which have all been recognised as influencing productivity in previous research efforts, were also found as significantly impeding productivity in the state and hence were included in the questionnaire. Thus, based on the insight gained from the literature and these discussions, 44 factors were identified as influencing productivity in Kerala, and a questionnaire was designed to study the impact of these factors.

The questionnaire consisted of three sections: part one sought demographic information from the respondents, part two asked the respondents to rate the effect and frequency of the 44 factors and part three required the respondents to rate the productivity observed at their ongoing project. A 5-point scale was used to measure the effect of the factors on labour productivity. In this scale, 1 represents "no effect", 2 represents "slight effect", 3 represents "significant effect", 4 represents "very significant effect" and 5 represents "extremely significant effect". In addition, the respondents were asked to rate the frequency of occurrence of each factor with respect to their ongoing project on a three-point scale, with 1 indicating "low", 2 indicating "medium" and 3 indicating "high". In section three of the questionnaire, the respondents were asked to rate the productivity of the ongoing project on a five-point scale varying from "very low" to "very high". Questionnaires were also prepared in the local language (Malayalam), as many of the respondents would be unable to comprehend the questions in English.

The preliminary questionnaire was pilot-tested on a small sample of the respondents to ensure the clarity and comprehensibility of the questions and to determine the ease of completion. Eight construction practitioners with rich experience in construction participated in the pilot study. The participants included five project managers and three site engineers/supervisors. The respondents suggested minor changes to the questionnaire, mainly to improve its comprehensibility and efficiency. Few questions had to be rephrased to remove

ambiguities in the questions. The questionnaire was revised, incorporating the comments received from the respondents.

Sample Population

The state of Kerala has been witnessing a boom in the construction of high-rise buildings, both for residential and commercial purposes, in recent years. The sample population targeted, therefore, included project managers, site engineers, supervisors and craftsmen working on high-rise projects in Kerala. Most of the high-rise projects in Kerala were being constructed in the private sector, with the major builders being members of the Confederation of Real Estate Developers' Associations of India (CREDAI). Members of the CREDAI Kerala Chapter were approached for permission to visit their construction sites. The construction sites of the members who responded positively were personally visited to collect responses to the questionnaire.

Sixty-seven high-rise project sites spread across Kerala were visited to collect responses to the questionnaire. The majority of the projects were residential construction projects. There were a total of 185 responses to the survey, including 35 project managers, 90 site engineers/supervisors and 60 craftsmen. The site engineers and supervisors are combined in the same category, as the title is used interchangeably on construction sites across the state.

Data Analysis

An importance index was calculated for each factor using the following formula (Jarkas and Bitar, 2012; Kadir et al., 2005; Lim and Alum, 1995):

$$Importance\ index = \frac{5n_1 + 4n_2 + 3n_3 + 2n_4 + n_5}{5(n_1 + n_2 + n_3 + n_4 + n_5)} \quad \text{Eq. 3}$$

where n_1 represents the number of respondents who answered "extremely significant effect", n_2 represents the number of respondents who answered "very significant effect", n_3 represents the number of respondents who answered "significant effect", n_4 represents the number of respondents who answered "slight effect" and n_5 represents the number of respondents who answered "no effect".

The frequency index was evaluated using the following expression (Kadir et al., 2005):

$$Frequency\ index = \frac{3n_1 + 2n_2 + n_3}{3(n_1 + n_2 + n_3)} \quad \text{Eq. 4}$$

where n_1 represents the number of respondents who answered "high", n_2 represents the number of respondents who answered "medium" and n_3 represents the number of respondents who answered "low".

Multiplication of the importance and frequency indices yielded a severity index (SI) for each factor (Kadir et al., 2005), which was used to rank the overall impact of the factor on construction labour productivity:

$$\textit{Severity index} = \textit{Importance index} \times \textit{Frequency index} \quad \text{Eq. 5}$$

Table 2 presents the overall ranking of the factors as well as the ranking for each category of respondent based on the severity index.

To test the agreement among the respondents in ranking of factors, a Spearman rank correlation was used (Table 3). A high correlation coefficient indicates strong agreement among the respondents in the ranking of factors. A strong correlation existed between project managers and site engineers in the ranking of factors, whereas a moderate correlation existed between site engineers and craftsmen in the ranking of issues. However, there was only a weak correlation between project managers and craftsmen in the ranking of factors, as evident from Table 3.

Table 2. Ranking of Factors Influencing Construction Labour Productivity Based on Severity Index (SI)

Factors Affecting Productivity	**All Respondents**		**Project Managers**		**Site Engineers/ Supervisors**		**Craftsmen**	
	SI	**Rank**	**SI**	**Rank**	**SI**	**Rank**	**SI**	**Rank**
Unavailability of material on time at workplace	0.442	1	0.425	1	0.484	1	0.386	2
Delayed material delivery by the supplier	0.395	2	0.374	7	0.428	2	0.355	3
Strikes called by political parties or hartals	0.394	3	0.402	3	0.383	4	0.404	1
Frequent revisions of drawing/design resulting in additional work/ rework	0.362	4	0.38	5	0.369	5	0.342	4
Unavailability of drawings on time at the worksite	0.357	5	0.371	8	0.411	3	0.274	16
Craftsmen absenteeism	0.346	6	0.369	9	0.352	10	0.318	6
Improper project coordination	0.341	7	0.418	2	0.35	12	0.287	9
Harsh weather conditions	0.34	8	0.344	11	0.357	8	0.314	7
Craftsmen turnover	0.329	9	0.376	6	0.327	19	0.307	8
Poor project planning and scheduling	0.329	10	0.397	4	0.354	9	0.257	23
Errors in the drawings	0.325	11	0.345	10	0.363	7	0.263	21
Equipment necessary to do the job not available on time	0.324	12	0.316	18	0.366	6	0.267	18
Lack of experience of craftsmen	0.315	13	0.321	16	0.338	15	0.277	14
Poor pay	0.31	14	0.281	32	0.312	24	0.323	5

(*continued on next page*)

Table 2. (*continued*)

Factors Affecting Productivity	All Respondents		Project Managers		Site Engineers/ Supervisors		Craftsmen	
	SI	Rank	SI	Rank	SI	Rank	SI	Rank
Lack of experience of supervisor	0.306	16	0.336	12	0.346	13	0.235	32
Craftsmen unaware of safety precautions	0.303	17	0.3	26	0.352	11	0.236	31
Poor quality of materials	0.3	18	0.314	20	0.337	16	0.242	28
Lack of maintenance of tools and plants	0.299	19	0.311	21	0.346	13	0.228	35
Rework due to field errors committed by craftsmen	0.298	20	0.309	22	0.335	17	0.238	29
Unsafe working conditions	0.297	21	0.29	29	0.319	29	0.268	17
Unavailability of tools on time at the worksite	0.296	22	0.272	37	0.316	22	0.279	13
Lack of team spirit among craftsmen	0.295	23	0.278	34	0.309	28	0.282	10
Lack of adequate space for storage of materials	0.292	24	0.294	27	0.312	25	0.258	22
Inadequate instructions provided by supervisor	0.291	25	0.305	24	0.322	20	0.238	29
Lack of recognition of good and efficient workers	0.286	26	0.317	17	0.287	34	0.266	19
Communication problem among craftsmen and supervisors	0.286	27	0.27	38	0.314	23	0.252	25
Labour strikes	0.285	28	0.268	39	0.296	32	0.274	15
Slow response on doubts arising from the drawings	0.278	29	0.323	15	0.285	35	0.243	27
Poor quality of tools provided /used	0.278	30	0.274	36	0.312	26	0.231	34
Accidents causing stoppage of work at the site	0.276	31	0.259	41	0.294	33	0.257	23
Disputes with consultants/ owner causing stoppage of work	0.272	32	0.275	35	0.298	31	0.233	33
Lack of interaction among the site community	0.272	33	0.281	31	0.309	28	0.215	39
Interference from other trades or other crew members	0.271	34	0.306	23	0.275	38	0.245	26

(*continued on next page*)

Table 2. (*continued*)

Factors Affecting Productivity	All Respondents		Project Managers		Site Engineers/ Supervisors		Craftsmen	
	SI	Rank	SI	Rank	SI	Rank	SI	Rank
Lack of periodic meeting among the management, site personnel and the contractors	0.271	35	0.328	14	0.311	27	0.189	42
Lack of weekly project evaluation meetings	0.267	36	0.303	25	0.301	30	0.202	40
Lack of monetary incentives	0.266	37	0.247	43	0.265	39	0.279	12
Unrealistic project goals and deadlines	0.259	38	0.314	19	0.282	36	0.198	41
Poor temporary facilities at the site	0.258	39	0.243	44	0.249	42	0.28	11
Site congestion	0.252	40	0.28	33	0.261	41	0.222	38
Design difficult to construct	0.25	41	0.251	42	0.265	39	0.227	36
Disregard of craft worker suggestions/ideas	0.246	42	0.294	27	0.241	43	0.225	37
Supervisor absenteeism	0.241	43	0.284	30	0.281	37	0.166	44
Excessive overtime	0.219	44	0.262	40	0.24	44	0.167	43

Table 3. Spearman Rank Correlation

Respondents	Project Managers – Site Engineers	Project Managers – Craftsmen	Site Engineers – Craftsmen
Spearman rank correlation	0.751*	0.381	0.541*

*Correlation significant at 0.01 level

RESULTS AND DISCUSSION

The factors with the highest impact on productivity, considering all responses, are the timely availability of materials at the worksite, delayed material delivery by the supplier, strikes called by political parties or *hartals*, frequent revisions of drawings/design resulting in additional work/rework and the unavailability of drawings at the worksite at the required time. The project managers, however, ranked improper project coordination and poor project planning and scheduling among the top five factors ahead of delayed material delivery by the supplier and unavailability of drawings at the worksite at the required time. Poor pay has emerged as a top factor for the craftsmen, who ranked drawing availability much lower than the other groups of respondents. The highest ranked factors, considering all responses as well as the various categories of respondents, are discussed below. Insight into the differences in priority attached to the factors by the various respondents is also presented.

With a severity index of 0.442, unavailability of materials was ranked as the most important factor affecting construction labour productivity, considering all responses. Project managers and site engineers have also ranked material unavailability as the most important factor. The craftsmen, however, ranked strikes called by political parties or hartals ahead of material unavailability. Unavailability of materials can lead to idle time, as workers must either wait for materials or move to another area where materials are available. 40% of the respondents indicated that material unavailability was a problem that occurred with high to medium frequency at their construction sites. Material shortage was identified as the most important factor influencing productivity by various researchers (Borcherding and Garner, 1981; Enshassi et al., 2007; Kadir et al., 2005; Kaming et al., 1997; Makulsawatudom, Emsley and Sinthawanarong, 2004; Olomolaiye, 1988; Rivas et al., 2011), thus corroborating the findings of this study.

The factor that was ranked second is also closely related to the availability of materials. Delay in material delivery by the supplier can result in a shortage of materials at the worksite. 35% of the respondents had experienced delayed material delivery with medium to high frequency at their construction sites. Discussions with construction personnel revealed that delayed material delivery was mostly due to unavailability of materials in the market or delayed payment for the materials. The construction industry in Kerala has faced many problems related to materials in recent times. With sand mining from rivers prohibited by law, the industry has experienced an acute shortage of fine aggregate during the last few years. An increase in the prices of various building materials has also adversely affected construction activities in the state. Project managers have ranked delayed material delivery considerably lower than have the other groups of respondents, with factors related to improper project coordination and poor project planning and scheduling rated with a higher impact on productivity. Project managers comprehend the importance of proper project planning and coordination on timely delivery of materials at the worksite and hence rate these factors ahead of material delivery. Kadir et al. (2005) also identified non-payment to suppliers causing stoppage of material delivery to the site as an important factor influencing productivity in Malaysia.

With an SI of 0.394, strikes called by political parties or hartals was rated as the third most important factor affecting labour productivity. Craftsmen ranked political strikes and hartals as the most detrimental factor influencing productivity. Over half (53%) of the respondents have rated the problem as occurring with medium to high frequency in their experience. A hartal is a form of mass protest, usually organised by political parties, involving a total shutdown of offices, shops and workplaces. Kerala has long witnessed a larger number of hartals compared to other states of India. Calls for hartals by political parties halts all work in Kerala, which is never the case in most other states in India. Work stops in most construction sites in Kerala in the event of a hartal. On those sites where work is not stopped, labour turnout drops on hartal days, thereby significantly affecting productivity. This factor has not been identified in any of the previous studies as significantly impairing productivity. Political strikes and hartals are a rarity in other countries, whereas the unique political environment existing in Kerala frequently kindles political strikes and hartals; hence, it is not surprising that this factor has been rated as a top factor by all categories of respondents.

Frequent revisions of drawings/design, resulting in additional work/rework, was rated as another important factor influencing productivity by all categories of respondents. Discussions with construction personnel of the state revealed that the majority of design and drawing revisions were made to satisfy changing owner/client requirements. Borcherding (1976) observed that the morale and attitude of project personnel are adversely affected by lack of progress due to changes. This outcome agrees with the findings of other studies wherein change orders were identified as an important factor influencing productivity (Jarkas and Bitar, 2012; Kadir et al., 2005). Rework was recognised as a significant factor impacting productivity in Uganda, the US, Indonesia, the UK and Chile (Alinaitwe, Mwakali and Hansson, 2007; Borcherding and Garner, 1981; Kaming et al., 1997; Olomolaiye, 1988; Rivas et al., 2011). In Chile, the major reason for most rework was found to be change orders, followed by design errors or lack of project definition, while only 20% of rework was related to field errors or misunderstandings (Rivas et al., 2011). Drawings and specification alteration during execution was also recognised as a major factor impacting productivity in a study of the Gaza Strip (Enshassi et al., 2007).

Timely availability of drawings has also been ranked among the top five factors impacting productivity. However, craftsmen perceived the factor to be less severe than did other categories of respondents. This difference of perception is in agreement with existing studies (Dai, Goodrum and Maloney, 2007). Craftsmen depend on their supervisors to impart information regarding their work and seldom go through the plans and drawings. Hence, craftsmen have ranked drawing unavailability and errors considerably lower than did project managers and site engineers/supervisors. Late issuance of construction drawings by consultants was also an important factor influencing construction productivity in a survey conducted in Malaysia (Kadir et al., 2005).

Project management inefficiencies such as improper project coordination and poor project planning and scheduling have been perceived by project managers as significantly impairing productivity. Project managers rate these factors to be more severe than do the other groups of respondents. The project managers, in their position at the forefront, can understand the impact that poor project planning and scheduling and improper project coordination can have on overall project performance. Many of the problems stated as important by the other participants reveal a lack of proper project preparation on part of the management. 60% of the project managers indicated that improper project coordination occurred with medium to high frequency in their projects, while half of the project managers believed poor planning and scheduling to occur with medium to high frequency in their projects. However, craftsmen ranked poor project planning and scheduling considerably lower than the other factors. Construction contractors that participated in a survey seeking to identify factors influencing productivity of water and wastewater plant construction in the deep south USA also identified management and job planning among the top factors (Mojahed and Aghazadeh, 2008).

The factors pertaining to labour motivation were rated to have severe effects on productivity by craftsmen – poor pay has been rated fifth, lack of team spirit among craftsmen tenth, poor temporary facilities at the site eleventh and lack of monetary incentives 12th. However, site engineers/supervisors and project managers ranked these factors much lower than did craftsmen. Borcherding and

Garner (1981) reported that the most frequently mentioned motivators by craftsmen were lower-level motivators, such as pay and other monetary benefits. Studies by other researchers have also identified pay and incentives among the most important motivation factors (Kaming et al., 1998; Parkin, Tutesigensi and Buyukalp, 2009; Zakeri et al., 1997). The difference in perception between site engineers/supervisors and project managers and craftsmen of factors influencing labour motivation is notable. Proper motivation of members of the construction workforce can result in a significant improvement in their performance. Project managers and site engineers/supervisors should realise the importance of a motivated workforce and work to build up a cooperative atmosphere in their organisation, in which workers are valued and their motivational needs are satisfied. This work would in turn be beneficial to the management by providing significant productivity gains.

Differences in emphasis between site engineers/supervisors and the other categories of respondents were also observed in availability of equipment and its maintenance and craftsmen being unaware of safety precautions, with site engineers/supervisors rating these factors higher than did other groups of respondents. At a construction site, day-to-day planning is often left to the site engineer/supervisor. In the event of unavailability of necessary equipment, alternative plans must be drawn by the site engineers/supervisors to prevent idling of the workforce; therefore, a greater importance is attached to equipment unavailability by site engineers/supervisors. When craftsmen are unaware of safety precautions, time is lost in instructing the workforce on the appropriate safety measures and enforcing the safety precautions. An increase in the frequency of accidents can also result, hence the greater emphasis on this factor. The factors of craftsmen turnover, lack of recognition of good and efficient workers and crew interference were rated lower by site engineers/supervisors than by other categories of respondents. Most site engineers/supervisors who participated in the survey have little experience (42% of the site engineers/supervisors had less than 5 years of experience) and no management training (only 30% of the site engineers/supervisors were graduate engineers, the rest being diploma holders with no training in management of construction projects) and hence may potentially fail to contemplate the effects of the above factors on labour productivity.

The craftsmen perceived issues relating to tool availability, labour strikes, unsafe working conditions and accidents as more prominent in influencing productivity than did the other groups of respondents. However, it was surprising to note the low priority attached by craftsmen to the lack of experience of the supervisor. Most (72%) of the craftsmen who participated in the survey had more than 10 years of experience, whereas only 32% of the site engineers/supervisors had more than 10 years of experience, explaining the disdain to experience of the site engineers/supervisors. Poor quality of materials was also ranked lower by craftsmen than by other respondents, as craftsmen likely perceive this factor to be beyond their control.

Project managers emphasise the need for periodic structured meetings among the project participants, realistic project goals, deadlines and quick review, revision and approval of drawings to improve construction labour productivity. However, meetings are of low priority to the workforce, which rarely participates in these meetings. All results, therefore, reveal that the project

management are more focused on managerial issues than are the other groups of respondents.

A difference of emphasis thus exists among the project participants in the perceived impact of the factors on construction labour productivity. Planning for productivity improvement by the project managers in isolation, without concern to the issues raised by the other project participants, would be useless and could result in resistance to adoption of such measures (Chan and Kaka, 2007). The results of this study could aid project managers in making effective plans for productivity improvement by incorporating the differences of opinions of all participants in the construction process.

CONCLUSIONS

Project managers, site engineers, supervisors and craftsmen participated in a survey intended to identify and rank the major factors influencing construction labour productivity in the state of Kerala in India. Among the 44 factors explored, timely availability of materials at the worksite was identified as the most critical factor impacting productivity. Delayed material delivery by the supplier, strikes called by political parties or hartals, frequent revisions of drawing/design, resulting in additional work/rework, and unavailability of drawings at the worksite at the required time were the other major factors identified in the survey. A Spearman rank correlation revealed strong correlation between project managers and site engineers in the ranking of the factors; however, only a moderate correlation existed between site engineers and craftsmen, and a weak correlation existed between project managers and craftsmen in the ranking of the issues. Project managers rated factors relating to project management inefficiencies, such as poor project planning and scheduling, improper project coordination and unrealistic project goals and deadlines, as having a significant impact on productivity. Craftsmen ranked factors related to motivational aspects, such as pay, incentives, safe working conditions, team spirit and labour strikes, higher than did the other groups of respondents. Site engineers/supervisors and project managers were more concerned than craftsmen about the availability and quality of drawings. Site engineers/supervisors also emphasised timely availability of equipment in achieving productivity improvement. The findings of this study emphasise the relative importance attached by the various project participants on issues influencing productivity, all of which must be considered to make effective plans for productivity improvement.

The research findings demonstrate the need to adopt effective material management practices at construction sites across the state. Most construction sites in Kerala rely on outdated techniques for material transportation within the worksite, with many construction projects relying heavily on the unskilled labour force for transport of the construction materials to top floors of high-rise buildings. Implementation of efficient technology and adoption of modern equipment for material transportation and distribution and proper resource scheduling, combined with coordination with manufacturers and suppliers to ensure timely delivery of materials at the site, are vital to avoid material problems at construction sites.

The project managers who participated in the survey realise the importance of project planning, scheduling and coordination in improving productivity of the workforce. The tool that aids most construction managers in the state in planning is the bar chart. Planning for resources is mostly performed on an ad-hoc basis, with resources being arranged when need arises. Adoption of project management software for planning and scheduling, with particular emphasis on resource planning, is essential to maintain and improve labour productivity at construction sites.

A factor that was rated by all project participants as having a detrimental effect on productivity was political strikes or hartals. This factor, unique to Kerala, is a persistent problem in the state and emphasises the necessity of wilful government actions to abolish hartals in the state.

Another area requiring immediate attention is the management of drawings. Interaction among the clients, owners, designers and management from the design phase itself is essential to minimise costly drawing/design errors and revisions, while proper coordination between designers and project management will ensure that drawings are available at the worksite at the required time. The respondents of the survey remarked that designers fail to perceive the impact of drawing quality on construction productivity. A lack of knowledge about the concept of productivity exists among all participants in the construction process of the state, including project managers, contractors, subcontractors, designers, site engineers, supervisors and craftsmen. The focus of the majority of construction personnel on the construction sites is production or output rather than productivity. Proper orientation and training of the participants in the construction process on the productivity concept is essential so that the emphasis may shift from production or output to productivity.

Motivation of the workforce is also important to achieve productivity improvement, as emphasised by the craftsmen who participated in the survey. The majority of the construction labour force consists of migrant labourers who come to Kerala looking for better financial conditions; thus, pay hikes, incentives, bonuses and recognition of workers can serve to boost productivity, while involving the workforce in planning and decision-making will ensure their cooperation in productivity enhancement initiatives. Stringent measures must also be adopted to ensure safe and healthy working conditions for the construction workforce.

This study corroborates the results of previous studies regarding external factors beyond the control of management rarely impacting productivity. Except for political strikes and hartals, all other factors are within the control of management and can be eliminated by effective management actions. Hence, as remarked by Tucker (1986), to achieve productivity enhancement, management must improve. A professional approach to construction management, combined with adoption of efficient and appropriate technology in construction and upgrading of skill and training of the participants in the construction process, is the proper path forward to achieve improved construction labour productivity. This research has identified factors impacting construction labour productivity in the Indian context from the perspective of various project participants, and the findings will aid construction managers in devising appropriate strategies for productivity improvement.

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