Regional Variations in Construction Labor Productivity - The Case of Two Indian States

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This paper aims to assess the differences in the perception of construction labor productivity (CLP) factors by the government officials in the construction sector in the state of Maharashtra and Arunachal Pradesh. Data was collected through a questionnaire. The study compared the importance of factors in both the states by ranking them using the frequency index. Results show that significant differences exist in the perception of the relative importance of factors in both the states. The study has made it easier to evaluate the relative influence of each factor on CLP and determine the extent to which the level of infrastructure growth and investment of the region affecting it.

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Introduction

Construction sector is one amongst the largest contributors to the economy of the world. Every year approximately US$10 trillion is being spent on activities related to construction goods and services all over the world (Barbosa et al., 2017). Construction sector has employed more than 35 million people (as in October 2016) and is expected to become the largest employer in India having more than 75 million people by 2022 (KPMG, 2016). The spending on infrastructure in the construction sector has grown to 9% of GDP in 2017. Consequently, tremendous efforts are being made to understand the growth drivers and constraints in this sector. One of the constraints has been the low productivity of the construction industry. In fact, the growth rate of construction labor productivity is the lowest; during the period from 1980 to 2008, the growth in labor productivity was just at an annual rate of 0.72 percent in the Indian construction sector (Goldar et al., 2014) while in other sectors such as manufacturing it is growing at 3.6% (Barbosa et

al., 2017). It appears that if the same trend continues, it would be difficult to suffice the growing housing and infrastructure needs of the world. It is estimated that investment in infrastructure by 2022 will be around Rs 50 trillion (US$ 777.73 billion) in order to ensure sustainable development in India (India Brand Equity Foundation, 2019). This demand, if supported by proper utilization of resources through improved labor productivity, shall lead to the economic development of the nation.

Workforce related aspects consistently rank high among causes of delay in construction projects.

Productivity determines the measure of the efficiency of conversion of resources including human and material to goods and services. Construction being a labor intensive sector and the major productive resource being the labor force, its productivity fundamentally depends on human effort and performance (Rojas & Aramvareekul, 2003). In addition, it is observed that the labor component is of great significance with respect to the four constraints of project management, i.e., time, cost, scope, and quality. Out of the total project cost, 30% to 50% consists of the labor costs in the construction phase of a project (Harmon & Cole, 2006). These labor costs, if efficiently tapped, shall portray a clear image of the economic success of the project. Workforce related aspects consistently rank high among causes of delay in construction projects (Assaf et al., 1995; Kaming, Paul O Olomolaiye, et al., 1997; Al-Khalil & Al-Ghafly, 1999; Odeh & Battaineh, 2002).

The Indian construction industry is facing a shortage of both skilled and unskilled labor (Venkatesh et al., 2012). The bulk of the workforce (82.45%) constitutes unskilled workers, 10% constitutes skilled workers and the rest by engineers, foremen, workers and staff (KPMG, 2013). Construction labor productivity (CLP) being one of the most important and flexible resources, it is used as a major performance indicator to evaluate the success and completion of a construction project. Hence, improving labor productivity is of great interest to practitioners (Abdul Kadir et al., 2005; Liu & Ballard 2008).

The actual status of CLP in the country or a region can be best estimated only if we know the state of affairs at the regional level. Until now, majority of the studies have been carried at the national level, whereas the disparities in CLP at the regional level have been generally neglected. As a result, the objective of this study is to assess and compare labor productivity factors at the regional level. In the present study, the researchers aim to determine the differences in the perceptions of the relative importance of the factors affecting CLP through interviews with government officials of Maharashtra and Arunachal Pradesh. Accordingly, the researchers focus on the perceptions of the government officials designated to supervise or overlook the construction activities in both the states rather than comparing the actual productivity differentials by using activity-based sampling techniques or the labor productivity data.

Construction Labor Productivity

It has been observed that there are notable differences in labor productivity across the majority of the countries and also at regional levels (Enflo & Hjertstrand, 2009). The patterns of labor productivity within industries, regions, and industries within regions show statistically significant differences. The contribution of each industry to each region is different, and the patterns have evolved with time (Webber & Horswell, 2009). Comparison of the CLP among the United States, United Kingdom and Jordan on the basis of standard baseline productivity data showed that differences existed due to differences in skill level and work methods of the labor (Sweis et al. 2011). Comparison of the changes in labor and partial factor productivity of construction labor in Canada and United States suggests that the growth of labor productivity has almost stagnated in the US while it is still growing in Canada, although in absolute terms, the CLP in Canada is still lower than in the US (Nasir et al., 2014). When the activity-based CLP is compared between the United States and China, significant gaps were found in equipment intensive construction activities, whereas there were smaller gaps in labor intensive construction activities (Shen et al. 2011). CLP of seven Indonesian regions shows differences on the basis of the output, working time, skills and motivation of artisans (Kaming et al, 2002). Labor productivity is thus seen to have variations with region.

Regional Variations in India

Productivity growth is seen to be higher in countries with sufficient and systematic provision of infrastructure services, thereby leading to the economic growth of the region (World Bank,1994). It is essential to understand the linkages of labor productivity and economic growth with the level of infrastructure development of a region. Increased spending and investment in infrastructure services improve the labor productivity of the region (Agénor, 2010). Unbalanced application of technology in construction is a major barrier to growth in improving CLP (Ma & Liu, 2018). Thus, in order to achieve economic development, it is imperative to provide infrastructure services to ensure that the demands of the business, families and users are adequately met (Srinivasu & Srinivasa, 2013). Reliability of infrastructure services is one of the major considerations in decisions related to investment by the private investors. It has been observed that as economic output grows, there is parallel growth in the infrastructure capacity also. Further, infrastructure is seen to have a significant positive influence on Foreign Direct Investment (FDI) in the Indian context (Mukherjee, 2011). As infrastructure development impacts labor productivity, it is used as an assessment tool to select the states in India for the comparison of CLP. The extent of infrastructure development and its quality is used as the criterion to select the states of India for this comparative study. The review of the extent and quality of infrastructure has been limited to the tra-

ditional infrastructure sectors such as roads, railways, airports, and seaports.

Analysis of the data based on the above- mentioned criteria shows that significant differences exist across the Indian states in terms of the extent of road and rails infrastructure. As evident from Table 1, Maharashtra and Arunachal Pradesh seem to lie fairly on the opposite sides of the spectrum of the considered criteria. In addition, the cumulative FDI equity inflows from January 2000 to December 2017 at the Mumbai region (covering Maharashtra, Dadra & Nagar Haveli, and Daman & Diu) and Guwahati region (covering Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, and Tripura) are US $ 114047.05 million and US $ 103.81 million respectively. While the Mumbai region contributed 30.93%, the Guwahati region had a share of only 0.03% of the total FDI inflows in the stipulated period, and this goes to show the vast differences in the investments made in both the regions. Compared to the ten airports in Maharashtra with the Mumbai airport itself handling 31.98 million domestic passengers (as of February 2019), commercial flights have recently started in Arunachal Pradesh from 2018 (India Brand Equity Foundation, 2019a). With no direct connectivity to the sea or the ocean, opportunities are being searched to utilize the perennial rivers in Arunachal Pradesh for inland water transport and boost the local economy. On the other hand, the two major ports, namely Mumbai Port Trust and Jawaharlal Nehru Port Trust in Maharashtra collectively handled traffic of 131.29 million tons during 2018-19 (India Brand Equity Foundation, 2019b). States like Maharashtra and Arunachal Pradesh, which are although parts of the same country have a vast variation in the utilization of infrastructure services for the local economy. It thus becomes necessary to have good quality infrastructure in attracting local and foreign investments to the region (Coughlin et al., 1991; Khadaroo & Seetanah, 2008). Taking into consideration the huge differences in Maharashtra and Arunachal Pradesh, it has been decided to compare the perspectives of government officials and see if similar observations are obtained in terms of the factors affecting CLP.

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Construction Labor Productivity Factors

In order to determine the factors affecting CLP, an extensive search for relevant articles on CLP was carried out on the bibliographic database, Scopus. In order to ensure that all the credible papers are covered, the method adopted by (Al-sharif & Kaka, 2004; Ke et al., 2009; Lin et al., 2014; Yi & Chan, 2014; Darko & Chan, 2016) was followed. This method involved a three-stage review of the relevant literature.

Table 1 Infrastructure Development in Indian States

State	Total Road Length (km, 2011-12)*	Total rail track length (km, 2015-16)#
India	3965394	119630
Andhra Pradesh	256448	7132
Arunachal Pradesh	14980	26
Assam	284232	3447
Bihar	138517	6870
Chhattisgarh	75742	2676
Goa	11082	98
Gujarat	163149	7691
Haryana	42638	3110
Himachal Pradesh	50449	358
Jammu and Kashmir	36353	490
Jharkhand	26227	5968
Karnataka	303128	5140
Kerala	215438	2042
Madhya Pradesh	201261	9337
Maharashtra	396685	11053
Manipur	19252	6
Meghalaya	12103	13
Mizoram	11293	6
Nagaland	35189	22
Odisha	254709	5038
Punjab	93871	3579
Rajasthan	248604	8579
Sikkim	5616	0
Tamil Nadu	230200	6453
Telangana	NA	3058
Tripura	29248	243
Uttarakhand	52628	509
West Bengal	315404	10604

Source:*Central Statistics Office 2014
Indian Railways 2019

For the first stage, the method of Yi and Chan (2014) was replicated to search for relevant papers in Scopus. Under the title/keyword/abstract field, "factors" were combined with each of the words labor productivity, labor performance, labor efficiency, labor production rate, labor productivity rate, labor time utilization, crew productivity, workforce productivity, worker performance, and worker efficiency. It was decided to limit the search to subject areas of engineering, environment, business management, decision sciences, economics, econometrics, finance, and social sciences with the document type of article or review in English. Since there were more than 8400 hits, the results were narrowed down by using the exact keywords Human, Productivity, Labor Productivity, Job Performance, Efficiency, Construction Industry, Workload, Work Environment, Project Management, Worker, Human Resources, Labour Productivity, Human

Resource Management, Manual Labor, Construction Management, Cross-Sectional Studies, and Labour Force. After stage 1 search, it was found that the majority of labor productivity associated articles were published in the Journal of Construction Engineering and Management (JCEM). Total hit count was more than 2400.

Six top-ranked construction journals, as defined by Wing (1997) and three other peer-reviewed journals which are often cited (Yi & Chan, 2014) were included in the second stage. These are Construction Management and Economics (CME), Engineering, Construction and Architectural Management (ECAM), Journal of Management in Engineering (JME), International Journal of Project Management (IJPM); Automation in Construction (AIC), Building Research and Information (BRI), Building and Environment (BAE), Canadian Journal of Civil Engineering (CJCE), and Journal of Computing in Civil Engineering (JCCE). Since there were no papers from BRI and JCCE, only seven top-ranked journals were considered at this stage. After this exercise, less than 200 papers were left. Finally, a manual search on the largest search engine Google was carried out to look for papers that might not have been indexed by Scopus. After careful review of each paper, 23 were selected for this study. The top ten factors affecting CLP were identified from each of the 23 papers (Table 2). The factors with similar meaning from each of these papers were then grouped together and renamed to provide a holistic view of each. The papers used in this study and the ranking the factors affecting CLP based on their frequency of occurrence in different parts of the world are shown in Table 2. The final output of this study was the determination of 21 factors affecting CLP. It is seen that manager/ supervisor type, equipment or tools, and worker characteristics are among the most frequently identified characteristics affecting labor productivity.

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Sample

Majority of the infrastructure projects in India are procured via Public-Private Partnerships and Traditional Procurement route (Department of Economic Affairs, 2018). As per the same report, 7785 projects costing Rs. 43,570.49 billion (US$ 626.85 billion, 1 US$ = Rs 71.42 as on June 10, 2019) are implemented by the Government of India out of a total of 9066 projects costing Rs. 5,165,5.49 billion (US$ 743.17 billion) which represents 84.34% of the total project costs. This clearly shows that majority of the projects are implemented by government officials. Thereby, it was decided to go ahead with the questionnaire responses only from the government officials and not the private contractors.

At the end of the questionnaire survey, 143 responses were received from Maharashtra out of which 11 responses

Table 2 List of 10 Factors Affecting Construction Labor Productivity

Sr No	Factors	Sources																							Tally of Papers
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
1	Manager/ supervisor type				*	*	*		*	*	*	*	*			*	*	*		*			*	*	14
2	Equipment or Tools			*	*	*		*	*		*			*		*			*		*	*	*	*	13
3	Worker characteristic	*	*		*	*	*			*	*	*		*	*		*		*	*					13
4	Material			*	*	*		*	*			*				*		*		*		*	*	*	12
5	Drawings	*		*		*	*		*			*	*		*				*		*	*	*		12
6	Communication		*								*					*	*		*	*		*	*	*	9
7	Supervision &Inspection	*			*	*		*					*		*					*		*			8
8	Designs & Technical Specifications			*	*	*							*		*					*	*			*	8
9	External factors	*							*		*				*	*			*		*				7
10	Amount of rework	*		*				*							*	*			*					*	7
11	Site management			*	*									*						*		*	*	*	7
12	Coordination	*					*					*	*		*									*	6
13	Response to request or doubts of workers	*		*								*			*							*		*	6
14	Incentive & Motivation	*			*					*	*		*												5
15	Payment					*				*		*			*										4
16	Job Satisfaction of workers					*				*		*						*							4
17	Working overtime	*				*									*			*							4
18	Absenteeism and Turnover			*				*									*								3
19	Schedule error				*						*														2
20	Training						*					*													2
21	Interference							*											*						2

[#]**Sources:** 1 Jarkas (2015) 2 Kaming, Paul O. Olomolaiye, et al. (1997) 3 Hanna and Heale (1994) 4 Zakeri et al. (1997) 5 Rivas et al. (2010) 6 Ghoddousi et al. (2015) 7 Khaled and Remon (2016) 8 Hiyassat et al. (2016) 9 Enshassi et al. (2007) 10 Jarkas and Bitar (2012) 11 Thomas and Sudhakumar (2013) 12 Abdul Kadir et al. (2005) 13 Jarkas et al. (2015) 14 Mahamid (2013) 15 Jarkas (2010) 16 Ailabouni et al. (2009) 17 Alinaitwe et al. (2007) 18 Chan and Kaka (2014) 19 Naoum (2016) 20 Sanders and H. Randolph (1992) 21 Dai et al. (2009) 22 Dai et al. (2007) 23 Dai, Paul M. Goodrum, et al. (2009)

were discarded after data screening, identifying outliers, visual check of the respondent's profile and as a result, 132 valid responses were used for the study. The 132 valid respondents were government officials with minimum educational qualification of Diploma in Civil Engineering with the majority of respondents were Bachelors in Civil Engineering. The key role of 94 (71.2%) respondents in their respective organization was of supervision (Fig. 1). Eighty-three respondents have an overall job experience of more than 15 years, which clearly states the richness of data received (Fig. 2). Similar to the respondents in Maharashtra, the respondents in Arunachal Pradesh were engineers employed in different departments where it was observed that a large number of them have more than 15 years of experience. Additionally, the majority of the respondents were working as site engineers. Out of the 166 responses obtained from Arunachal Pradesh, 154 responses were valid. The potentially biased, unengaged responses were considered as invalid and were removed accordingly.

Fig. 1 Bar Chart Representing the Respondent's Key Role in the Organization

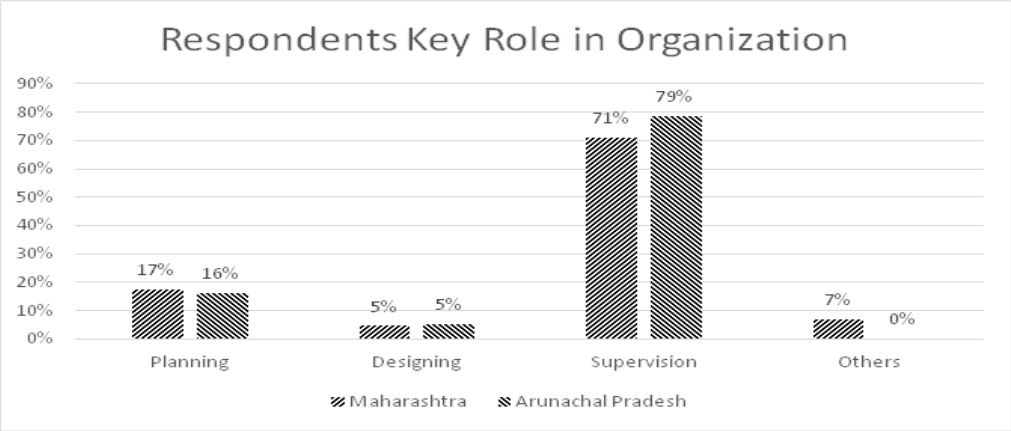
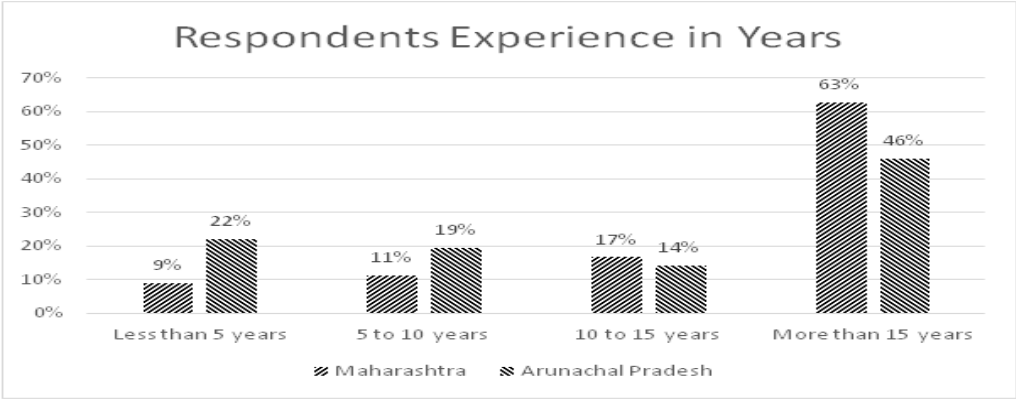


Fig. 2 Bar Chart Representing the Experience of Respondents in Years



Questionnaire

A questionnaire was prepared based on the factors extracted through literature review to gauge the perceptions of the government officials involved in the construction activities from both the states. Along with the 21 factors identified during the literature review, two questions concerning the timely completion of the project and within budget were added to gain an insight into the respondents' perspective. A pilot test was conducted to evaluate the clarity and suitability of the questions; to test the adequacy range of available options and gauge the effectiveness with which the respondents can complete the questionnaire. After some minor corrections in the wordings and structure of the questionnaire, the final version was shared with the respondents for their input.

The questionnaire sent out to the respondents comprises three sections. The first section provides instructions on how to fill the questionnaire. In the second section, definitions of factors affecting labor productivity were mentioned to clarify the meaning of each of the factors. In the last section, the respondents' opinion on the extent to which they experience the given factors during the execution of the projects is sought. The rating of the factors affecting CLP was asked from the respondents on a five-point Likert type scale of one to five with 1 - almost never; 2 – once in a while; 3 – sometimes; 4 – often; 5 – almost always, the extent to which the given items lead to a reduction in labor productivity.

Data Analysis

The data obtained from both the states were analyzed using frequency index to determine the frequency of occurrence of each of the event based on their importance. The formula for calculation has been used extensively by researchers like Ghoddousi et al. (2015); Hiyassat et al. (2016); Jarkas (2015); Jarkas et al. (2015); Khaled and Remon (2016); Naoum (2016); Zakeri et al. (1997) and many more to rank the importance of each of the factors in their studies. The formula for calculation of frequency index is shown in equation 1.

Frequency Index for each indicator =

$$\frac{n1+2(n2)+3(n3)+4(n4)+5(n5)}{5*N} \quad \text{.....(1)}$$

Where, n1, n2, n3, n4, n5 = number of responses with score 1, 2, 3, 4, 5 respectively

N = total number of valid observations

= n1 + n2 + n3 + n4 + n5

Based on the literature review, factors with similar meanings were aggregated into five groups namely management related factors, design considerations, labor related factors, materials and equipment, and project nature and working environment were formed. The frequency index and ranking of all factors of both the states are shown in Table 3. In order to determine the strength of as-

sociation and the level of agreement of the respondents of both the states on the ranking of the factors, Spearman's rank correlation test was used.

Table 3 Frequency Index & Ranking of the Factors

Factors and their groups	Maharashtra		Arunachal Pradesh	
	Frequency Index	Rank	Frequency Index	Rank
Management Related	0.620	2	0.553	4
Response to request or doubt of workers	0.598	14	0.582	9
Proper supervision and inspection of ongoing works	0.691	1	0.469	18
Irregularity of payments	0.618	10	0.567	11
Bottlenecks in communication system	0.617	11	0.525	14
Working overtime	0.605	13	0.520	15
Incompetency of manager/ supervisor	0.592	15	0.520	16
Poor site management	0.621	9	0.689	2
Design Considerations	0.596	4	0.537	5
Unrealistic schedule or error in activity sequencing	0.592	16	0.663	6
Reconstruction	0.526	21	0.669	5
Buildability and accuracy of specification	0.633	5	0.358	21
Unavailability and lack of clarity of working drawings	0.632	6	0.459	19
Labor Related	0.604	3	0.563	3
Training	0.665	4	0.565	12
Incentives and motivation	0.626	7	0.552	13
Poor coordination among different teams/ gangs	0.624	8	0.694	1
Job satisfaction of workers	0.608	12	0.504	17
Worker turnover	0.567	17	0.447	20
Dispute between workers	0.533	20	0.618	8
Materia & Equipment	0.683	1	0.683	1
Availability of required materials	0.685	2	0.687	3
Equipment/ tools/ technology	0.680	3	0.678	4
Project Nature & Working Environment	0.550	5	0.607	2
External factors	0.552	18	0.570	10
Interference from others	0.548	19	0.645	7

Discussion

The engineers of the two states perceived the importance of majority of factors differently. It is seen that the top five factors perceived to be significant by the engineers of Maharashtra were of proper supervision and inspection of ongoing works, availability of materials, equipment, tools and technology, worker training and buildability and accuracy of the specification. Whereas, poor coordination among teams and gangs, poor site management, availability of materials, equipment, tools and technology and reconstruction were the major factors as perceived by the officials from Arunachal Pradesh. In order to improve productivity, it is imperative that the direct work time which accounts for 35% to 45% of

a workers' time on job, should be improved (Construction Industry Institute, 2019). This direct work time may be improved by ensuring the timely availability of equipment, tools and materials to the workers. Apart from the common factor of availability of materials, equipment, tools and technology, there were differences in the perception of the important factors by the officials in their respective regions. Lack of materials and unavailability of tools and equipment have been major factors in affecting labor productivity (Kaming et al., 2002; Alinaitwe et al., 2007; Rivas et al., 2011).

With a population density of only 17 per sq.km, Arunachal Pradesh is a scarcely populated region. The unavailability of labor, especially skilled labor, could be a reason for poor coordination among the teams. Inexperienced workers coupled with poor site management can significantly lower the overall productivity. One of the reasons for poor site management could be the geographical terrain in Arunachal Pradesh. Limited working space along with uneven terrain can add to the congestion of the limited available working space leading to reduced productivity. Additionally, Kaming et al. (1998) stated that if the labor density is greater than one worker per 30 sq.m., it leads to a loss in labor productivity. Lack of knowledge and experience of the supervisor along with inadequate or improper guidance can lead to faulty work and thus rework or reconstruction of the work. Due to a large infusion of workers in Maharashtra from the nearby regions, most of the immigrant workers are first time workers and thereby unskilled. So, worker training becomes imperative for these workers and thus it is one of the major factors affecting CLP in Maharashtra. Accuracy of working specification and of working drawing has been given preference in Maharashtra compared to unrealistic schedule and reconstruction in Arunachal Pradesh. The morale and efficiency of the workers are adversely affected due to constant variation in the design consideration and change of scope of the work (Kazaz & Ulubeyli, 2007). Overall management related factors of bottlenecks in a communication system, incompetency of manager/ supervisor, and enforcing overtime working on the workers, irregularity of payments have been moderately important in both the states. The disputes between workers, interference from others and external factors are quite prominent in Arunachal Pradesh from the engineers' perspective.

Problems relating to material and equipment group were ranked as significantly important as affecting CLP in both the states. Management related issues were given more importance in Maharashtra whereas the officials from Arunachal Pradesh believed that the overall nature of the project and working environment, which included external factors and interference from others, had more prominence over labor related issues and design considerations. Non-availability of equipment was cited as one of the most important factors affecting labor productivity in the regional comparative studies of Newfoundland and rest of Canada (Hanna & Heale 1994). A close analysis of the factors reveals

that apart from external factors, all the other factors are directly or indirectly related to management inefficiencies. Approximately 41% of respondents in Maharashtra and 49% respondents in Arunachal Pradesh stated that the timely completion of the project is often affected by a reduction in labor productivity. Additionally, 29% of respondents in Maharashtra and 41% respondents in Arunachal Pradesh believed that reduction in labor productivity is often the reason for the failure of the project to complete within the stipulated budget. The trend has been similar to Tsehayae and Fayek (2014), who stated that project costs are significantly impacted by CLP, as the contribution of labor costs in the project is between one third and one-half of overall project costs. It has been suggested that these costs can be best reduced by productivity improvement (Yates & Swagata, 1993; Kaming et al. 1998).

The value of the Spearman's rank correlation coefficient was -.108 which indicates a weak relationship between the responses obtained from both the states. An overview of the results also states that there are vast differences in the perception of the importance of labor productivity factors in both states. Better availability of capital for infrastructure development ensures timely payment of wages to the workers. Assurance of timely wages also encourages the labor force to improve their skills and become more productive. This attracts more labor population to regions with better infrastructure growth prospects and thereby contributing to productivity improvement. On the other hand, firms are benefitted from the lower cost of trade and transport if access to both customers and their suppliers is good which is again ensured by better transport infrastructure facilities. Political stability plays a vital role in affecting the local regulatory environment and government policies of the region. If the government is stable and progressive towards infrastructure growth, confidence develops in the private sector to infuse more capital for investment. This again promotes multiple job opportunities and improves the economy of the region. With a stable government and minimal local conflicts, it is observed that Maharashtra has managed to maximize this opportunity for economic growth as well as stabilize its construction labor market. Arunachal Pradesh being highly vulnerable to natural disasters like floods, landslides, earthquakes, where it causes large scale loss to life and property each year. This may have forced the labour force to shift to more stable regions and has thus stalled the infrastructure growth. Corruption in the system, level of education of the workers, lack of implementation of new technologies in construction, among others, could also be the reasons for differences in the perceived importance of CLP factors by the respondents from both the regions. An attempt has thus been made to find out the reasons behind the differences in the perceived importance to the respondents in both states.

Conclusion

The objective of the paper was to assess the interrelations among the CLP

factors as perceived by the officials in Maharashtra and Arunachal Pradesh. Through literature review, 21 major factors were identified, and a questionnaire was developed to obtain the responses. The analysis was done using frequency index to determine the relative importance of each factor and the results obtained were discussed. Also, Spearman's rank correlation index determined the differences in perceptions of respondents from both the states. It was observed that along with the availability of materials, tools and equipment related factors, all other factors had varying but significant differences of importance as perceived in both the states. Additionally, officials largely were of the opinion that the timely and within the budget completion of the project is often affected by a reduction in labor productivity. An analysis of the results shows similar trends in other countries as well.

The comparative data informs the management of the construction firms for better planning and performance evaluation, and information that may affect their strategic decisions. The results will be useful for project managers to develop strategies for improving construction productivity. The comparison will assist contractors during the planning process to achieve the desired level of quality, cost effectiveness and help meet the timelines of construction projects. Strategy and policy formulation for construction activities at industry and corporate levels will get an impetus. This study shall be used to provide feedback to project managers and site supervisors the extent to which their project management practices and principles affect labor productivity and thereby impact the project duration and cost. Moreover, the obtained relationships among the factors will provide guidance to construction managers for effective resource planning, improved response to labor issues and their efficient utilization. In addition, this being the first study in the Indian context, the results can be used as a benchmark for future studies.

Limitations

Although the majority of respondents had overall work experience of more than 15 years, the number of responses obtained were limited in number and may not represent the views of the entire population. Thus, a relatively smaller sample size might have influenced the results. Additionally, the responses were obtained only from government officials. The current study focuses only on two regions and thus the conclusions drawn from it cannot be generalized to a broader range of the population. Because of limitations on the availability of data from other states, this research is intended for use in the state of Maharashtra and Arunachal Pradesh. Different geophysical, cultural and climatic conditions can have effects on the perceptions of the respondents, which have not been incorporated in the present study.

Future Scope

The sample size of the data can be improved to obtain better and unbiased results. Bigger sample size will help give better insights into the phenomena. This

data can also be collected from private contractors and actual field workers to gain insights into their perspectives. A comparison of the results of the responses obtained from the officials with those of contractors and the field workers can help the project management teams to efficiently and effectively manage the resources and cater to individual needs. The regional differences as discussed in the limitations if incorporated in future studies shall help provide a holistic picture of the problem discussed. Since this study focused only on two specific regions, similar studies can be extended to other regions to identify the relationships among the variables.

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