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Construction labour productivity: review of factors identified

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ABSTRACT

Construction Labour Productivity (CLP) is important to the construction industry as it has a direct impact on the competitiveness of small and medium enterprises. This article's purpose is to review the research carried out to date on identification of the factors related to CLP. A thorough literature review was conducted with all available scientific databases and a total of 88 papers were shortlisted with the keywords 'Construction Labour Productivity'. The articles were thoroughly reviewed to identify the factors related to CLP and rank them according to their importance mentioned in different studies using Jenks classification method. The importance of CLP factors according to geographic regions was also identified. The methods used for CLP estimation from the factors are briefly discussed and finally, the recommendations for the improvement of CLP made by researchers are summarized. The finding of the study will help in understanding the directions required for better management of CLP in different geographical regions.

KEYWORDS

Construction labour productivity; labour productivity factors; geographic regions; productivity management; Jenks classification method

Introduction

For the nation's economy to grow, construction productivity is very important and plays a significant role in the industry (Naoum 2016). The construction industry serves significantly as a source of employment and makes a remarkable contribution to the performance of the overall economy (Giang and Pheng 2011). Labour is known as the most crucial and flexible resource used in the construction projects and construction productivity is directly related to labour (Muqeem et al. 2012). Construction projects hire a large number of workers, thereby, it can be stated that manpower is the dominant productive resource, therefore construction productivity is highly dependent on human effort, efficiency and performance (Jarkas 2010).

There are several definitions provided of productivity by different researchers. The term 'productivity' is generally defined as the maximization of output while optimizing input (Naoum 2016; Durdyev et al. 2018). Henceforth, it is known as a measure of the ratio between an output value and an input value used to produce the output (Borcherding 1977; Ameh and Osegbo 2011; Durdyev and Mbachu 2011; Jang et al. 2011; Ibbs 2012; Jarkas and Radosavljevic 2013; Gundecha 2013; Yi and Chan 2014; Rami Huges 2014; Robles et al. 2014; Shashank et al. 2014; Naoum 2016; Sveikauskas et al. 2016; Dixit et al. 2017; Durdyev and Mbachu 2018; Ohueri et al. 2018; Alaghbari et al. 2019; Ayele and Fayek 2019; Dixit et al. 2019; Shoar and Banaitis 2019; Zhiqiang et al. 2019). Output consists of products or services and input consists of materials, labour, capital and energy (Drewin 1982). The Construction Labour Productivity (CLP) is defined as the units of work placed or produced per man-hour (Bekr 2017). Therefore it can be measured in terms of earned hours (Thomas et al. 1990). Yi and Chan (2014) defined 'Productivity' as the power of being productive, efficiency and the rate at which goods are produced. Griego and Leite (2017) defined productivity as work produced by the workers in a construction project. The most common CLP metrics are: unit rate (ratio of labour cost to units of output); labour productivity (ratio of work hours to units of output) and productivity factor (ratio of scheduled or planned to actual work hours) (Gouett et al. 2011).

Low level of productivity is one of the most challenging concern faced by the construction sector (Jarkas and Bitar 2012). Construction industries in many countries across the world are greatly concerned about low level of productivity (Lim and Alum 1995; Egan 1998; Ayele and Fayek 2019). Low level in productivity is dangerous and causes inflationary pressure,

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social conflicts and mutual suspicion to the nation's economy (Drucker 2012; Dixit et al. 2019; Shoar and Banaitis 2019). By acknowledging the factors that cause low CLP, project managers can address the problems at an early stage, thus minimize the time and cost overruns (Kaming et al. 1997; Kaming et al. 1998; Abdul Kadir et al. 2005; Palikhe et al. 2019; Seddeeq et al. 2019). The CLP significantly influences the profitability of construction companies; however, CLP exhibits the highest variability among project resources and thus, a major source of project risk (Tsehayae 2015). Labour in projects is also the most difficult element to define, manage and quantify the impact. In this sense, it still remains important to determine the factors affecting labour-productivity to manage labour-force effectively (Kazaz and Acıkara 2015). Understanding critical factors that affect CLP can help to develop strategies to reduce inefficiencies and to more effectively manage construction labour forces. This will not only improve the project performance of construction companies, but also make them more competitive and consequently increase the chances of survival within this highly competitive sector (Ailabouni et al. 2007; Robles et al. 2014).

The major objective of this study is to review the research carried out to date on identification of the factors related to CLP. A thorough literature review was conducted using available scientific databases to identify the factors related to CLP and rank them according to their importance as mentioned in different studies. The methods used for CLP estimation from the factors are briefly discussed and recommendations are made for the improvement of CLP. The findings of the study can be used, not only by academics, who are interested in the effect of the subject matter on the construction workforce, but also by both local and international industry practitioners, who may be further keen to venture into potential mega-scale projects. The study can help construction project management to develop a wider and deeper perspective of the motivational factors impacting the performance of skilled operatives and to provide project managers with guidance for focusing, acting upon, and controlling the critical factors influencing the productivity. Thus, the study would assist in achieving an efficient utilization of the workforce, and a reasonable level of competitiveness and cost-effective operation.

Research methodology

The study used relevant research publications by selecting the potential journals in accordance to their reputation and impact ratings as proposed in the methodology by Schweber and Leiringer (2012). A preliminary survey, carried out adopting 'Google Scholar & Scopus Search Engines' using keywords 'construction + labour + productivity'.

All journals used are prominent 'construction research' journals. In all journals, the authors carefully studied through the titles of all the articles appearing in each issue of all the volumes looking for any articles which were to be concerned with 'construction labour productivity'. The abstracts of all the articles which had some relevance to 'construction productivity' were examined closely and the ones which had the keyword 'labour productivity' in the abstract were considered for the study.

The following information was extracted from the articles: (a) the type of labour productivity being examined; (b) the level of analysis at which the labour productivity is examined; (c) the data collection methods and methodological approaches adopted; (d) the identified factors affecting labour productivity in construction and (e) recommendations made by respective researchers to improve productivity.

A data clustering method known as Jenks optimization (Jenks 1967) was used in this study for the classification of factors and select the most important factors. Jenks method divides data in such a way that variance within each class is the minimum but the variance among the mean values of the classes is the maximum. The advantage of Jenks classification method is that it identifies the real classes in the data. Another advantage is that it is developed with the intention of dividing data into a relatively few data classes. Therefore, Jenks optimization was used for the classification of factors based on their importance identified in literature. Finally, the class that contains the highest importance was selected.

Factors related to construction labour productivity

A detailed literature review from various journals was used to identify the factors related to CLP. The factors relate to CLP identified in different studies are summarized in Table 1. Only the topmost factors relate to CLP identified in different studies are given in the table. The table shows that the studies covered a wide range of geography.

Discussion of results

The literature presented in Table 1 is thoroughly revised to extract the information as mentioned in

Table 1. Review of literature on identification of factors related to construction labour productivity.

Author(s)	Country	Total factors identified	Top factors
Maloney (1983)	USA	N/A	(1) Work intensity; (2) Duration of work; (3) Work effectiveness; (4) Worker efficiency
Lim and Alum (1995)	Singapore	17	(1) Difficulty in recruitment of supervisors; (2) Difficulty in recruitment of workers; (3) High rate of labour turnover; (4) Absenteeism at the worksite; (5) Communication problems with foreign workers
Liberda et al. (2003)	Canada	N/A	(1) Worker experience; (2) Worker skills
Makulsawatudom et al. (2004)	Thailand	23	(1) Lack of material; (2) Incomplete drawing; (3) Incompetent supervisors; (4) Lack of tools and equipment; (5) Absenteeism.
Cooper (2005)	UK	N/A	(1) Overtime works; (2) Safety; (3) Realistic goals; (4) Use of technology; (5) Communication
Abdul Kadir et al. (2005)	Malaysia	50	(1) Material Shortage; (2) Default payments; (3) Change Orders; (4) Late instructions; (5) Poor site management
Enshassi et al. (2007)	Gaza	45	(1) Material shortage; (2) Lack of experience; (3) Poor supervision; (4) Misunderstanding between labour and supervision; (5) Change orders
Ailabouni et al. (2007)	UAE	32	(1) Proper work timings; (2) Leadership skills of supervisors; (3) Salaries on time; (4) Technical qualified; (5) Reasonably well-paying job
Sambasivan and Soon (2007)	Malaysia	28	(1) Poor planning; (2) Financial constraints; (3) Subcontractor problems; (4) Material shortage; (5) Labour supply
Alinaitwe et al. (2007)	Uganda	36	(1) Incompetent supervisor; (2) Lack of skills; (3) Rework; (4) Lack of tools and equipment; (5) Poor construction methods
Kazaz et al. (2008)	Turkey	37	(1) Quality of site management; (2) Material management; (3) Systematic flow of work; (4) Supervision; (5) Site layout
Dai and Goodrum (2011)	USA	83	(1) Supervisor does not provide information; (2) Sharing of equipment; (3) Project management bonus pays; (4) Project policies; (5) Machinery not available
Jang et al. (2011)	South Korea	25	(1) Safety accident; (2) Manager capability; (3) Work continuity; (4) Construction plan; (5) Work method
Durdyev and Mbachu (2011)	New Zealand	56	(1) Rework; (2) Level of workforce skills/experience; (3) Adequacy of construction methods; (4) Buildability issues; (5) Coordination issues
Ameh and Osegbo (2011)	Nigeria	14	(1) Use of wrong construction method; (2) Absence of materials; (3) Inaccurate drawings specifications; (4) Inadequate tools and equipment; (5) Poor supervision of operatives
Soekiman et al. (2011)	Indonesia	113	(1) Lack of material; (2) Delay in arrival of materials; (3) Unclear instruction to labourer; (4) Labour strikes; (5) Financial difficulties of the owner
Mohammed and Isah (2012)	Nigeria	N/A	(1) Improper planning; (2) Lack of communication; (3) Shortage of material; (4) Design factors; (5) Slow decision making
Gundecha (2012)	USA	40	(1) Lack of materials; (2) Shortage power/water; (3) Accidents; (4) Lack of machinery; (5) Poor site conditions
Jarkas and Radosavljevic (2013)	Kuwait	23	(1) Payment delay; (2) Rework; (3) Lack of financial incentives; (4) Change orders; (5) Incompetent supervisors
Ghoddousi and Hosseini (2012)	Iran	31	(1) Construction methods; (2) Site manager experience; (3) Lack of proper tools; (4) Inexperienced operatives; (5) Site managers ability
Doloi et al. (2012)	India	45	(1) Lack of commitment; (2) Inefficient site management; (3) Poor site coordination; (4) Improper planning; (5) Lack of clarity in project scope
Thomas and Sudhakumar (2013)	India	44	(1) Unavailable material; (2) Delayed material delivery; (3) Drawing not available; (4) Lack of equipment; (5) Poor pay
Yi and Chan (2014)	USA	N/A	(1) Management & Planning; (2) Labour Agreements; (3) Government; (4) Owner Characteristics; (5) Financing
Rami Huges (2014)	Australia	47	(1) Rework; (2) Poor supervisor competency; (3) Incomplete drawings; (4) Work overload; (5) Lack of material
Shashank et al. (2014)	India	34	(1) Motivation; (2) Manpower; (3) Material; (4) Safety; (5) Management
Robles et al. (2014)	Spain	35	(1) Level of Skill and experience; (2) Ability to adapt to changes and new environments; (3) Labour motivation; (4) Worker's integrity; (5) Number of breaks and their duration
Odesola and Idoro (2014)	Nigeria	15	(1) Craft workers pride in their work; (2) Lack of skills; (3) Reworks; (4) Incompetent Supervisors; (5) Personal problems
Hickson and Ellis (2014)	Trinidad and Tobago	42	(1) Lack of labour supervision; (2) Unrealistic scheduling and expectation of labour performance; (3) Shortage of experienced labour; (4) Construction manager's lack of leadership skills; (5) Skillset of labourers
Jarkas and Haupt (2015)	Qatar	37	(1) Errors in drawings; (2) Change orders; (3) Delay in instructions; (4) Lack of supervision; (5) Clarity of project specifications
Jarkas et al. (2015)	Oman	33	(1) Drawing errors; (2) Change orders; (3) Instruction delay; (4) Poor supervision; (5) Clarity of project specifications.
Choudhry (2015)	Saudi Arabia	31	(1) Skilled Labour; (2) Education & Experience; (3) Better communication; (4) Budget; (5) Safety
Muhammad et al. (2015)	Malaysia	10	(1) Lack of skilled workers; (2) Material delay; (3) Weather; (4) Access to site; (5) Crew
Kazaz and Acıkara (2015)	Turkey	37	(1) Social Insurance; (2) On time payments; (3) Amount of pay; (4) Dining hall and dorm conditions; (5) Health & safety conditions
Li et al. (2016)	China	N/A	(1) Age has negative impact; (2) Work Experience & BMI has positive impact
Shan et al. (2016)	USA	N/A	(1) Effective management programs; (2) Material management & safety programs
Naoum (2016)	UK	46	(1) Experience; (2) Design errors; (3) Buildability; (4) Project planning; (5) Communication
Hiyassat et al. (2016)	Jordan	23	(1) Feeling of achievement; (2) Experience; (3) Use of foreign workers; (4) Scheduling; (5) Use of machinery
Bekr (2017)	Jordan	37	(1) Poor planning; (2) Material shortage; (3) Equipment shortage; (4) Lack of labour; (5) Poor site management

(*continued*)

Table 1. Continued.

Author(s)	Country	Total factors identified	Top factors
Dixit et al. (2017)	India	24	(1) Decision Making; (2) Planning; (3) Logistics; (4) Labour availability; (5) Budget
Durdyev and Mbachu (2018)	Cambodia	36	(1) Poor leadership; (2) Poor planning; (3) Inadequate construction methods; (4) Poor labour supervision; (5) Ineffective communication
Afolabi et al. (2018)	Nigeria	17	(1) Availability of equipment and material; (2) Supervision; (3) Payment Method; (4) Welfare on site; (5) Weather Condition
Ohueri et al. (2018)	Malaysia	14	(1) Effective management and supervision; (2) Financial incentives; (3) Training and development; (4) Safe and friendly working environment; (5) Career Progression
Momade and Hainin (2019)	Qatar	10	(1) Achievement; (2) Proper recognition and rewards; (3) Interesting work; (4) Involvement in decision making; (5) Adequate training and development
Alaghbari et al. (2019)	Yemen	52	(1) Labour's experience and skill; (2) Availability of materials in site; (3) Leadership and efficiency in site management; (4) Availability of materials in the market; (5) Political and security situation
Palikhe et al. (2019)	Nepal	30	(1) Unavailable of tools on time at the worksite; (2) Delay in arrival of material; (3) Procurement delay; (4) Lack of monetary incentive; (5) Material payment delay
Shoar and Banaitis (2019)	Lithuania	27	(1) Unrealistic schedule; (2) Excessive number of labourer; (3) Rework; (4) Delay in salary payment; (5) Workforce overtime
Venkatesh and Saravana Natarajan (2019)	India	10	(1) Non-availability of Clear Work Front; (2) No proper Planning; (3) Skill of the worker;; (4) No proper Supervision; (5) Coordination between Equipment

methodology section. The major findings of the literature review are discussed in following sections.

Finding no. 1: Ranking and identification of CLP factors

The ranks provided to different CLP factors by different researcher are identified and presented in Table 2. Only the CLP factors which have been ranked among the top 5 are presented in the table. The 1 in table stands for most important and 5 for least important (among the top 5) identified by respective researchers. The table shows that the majority of researchers have come to conclusion that (ranked in descending order): '(1) Incompetent supervisors/poor management and planning, (2) Lack of materials/tools/equipment, (3) Worker efficiency/skills, (4) Lack of commitment/motivation and (5) Work effectiveness/experience" are the most critical factors affecting construction labour productivity. However, the following factors have been a common occurrence as top ranked one in most studies in descending order: '(1) Incompetent Supervisor/Poor management and planning, (2) Lack of material/tools/equipment, (3) Communication/coordination problems and misunderstanding, (4) Worker effectiveness/experience and (5) Worker efficiency/skills training'.

Finding no 2: Geographical distribution of CLP factors

The geographical distribution of the CLP related studies conducted so far are presented in Table 3. It can be noted from the table that most of the studies on identification of CLP factors have been carried out in the following countries: India (5), USA (5), Malaysia (4) and Nigeria (4). USA is a developed country and India, Malaysia and Nigeria are developing countries and are highly dependent on labour for majority of the construction work.

With respect to the geographical regions, the majority of the researchers in North America have concluded that (1) Sharing of Equipment/Machinery not available (Dai and Goodrum 2011; Gundecha 2012), (2) Management & Planning; Poor Supervision (Dai and Goodrum 2011; Yi and Chan 2014; Hickson and Ellis 2014), (3) Worker Efficiency (Maloney 1983; Liberda et al. 2003; Hickson and Ellis 2014) and (4) Financial Incentives (Dai and Goodrum 2011; Yi and Chan 2014) are the critical occurring factors affecting CLP.

In Europe, majority of the researchers have concluded that (1) Health and Safety (Cooper 2005; Kazaz et al. 2008; Robles et al. 2014; Kazaz and Acıkara 2015), (2) Project Planning and Management of Material/Workers (Kazaz et al. 2008; Naoum 2016), (3) Communication (Cooper 2005; Naoum 2016), (4) Delay in payments (Kazaz and Acıkara 2015; Shoar and Banaitis 2019) and (5) Unrealistic schedule (Cooper 2005; Shoar and Banaitis 2019) are the critical occurring factors affecting CLP.

In Africa, majority of the researchers have concluded that (1) Availability of Machinery and materials (Alinaitwe et al. 2007; Ameh and Osegbo 2011; Mohammed and Isah 2012; Afolabi et al. 2018), (2) Supervision of works (Alinaitwe et al. 2007; Ameh and Osegbo 2011; Odesola and Idoro 2014; Afolabi et al. 2018), (3) Worker skills (Alinaitwe et al. 2007; Ameh and Osegbo 2011; Odesola and Idoro 2014), (4) Reworks (Alinaitwe et al. 2007; Odesola and Idoro

Table 2. Ranking of CLP factors by different researchers as obtained through literature review.

Factors	Rank by Researchers	1	2	3	4	5	∑
Career progression	*(5)* Ohueri et al. (2018)	-	-	-	-	*1*	*1*
Owner characteristics	*(4)* Yi and Chan (2014)	-	-	-	*1*	-	*1*
Personal Problems	*(5)* Odesola and Idoro (2014)	-	-	-	-	*1*	*1*
Dorm conditions	*(4)* Kazaz and Acıkara (2015)	-	-	-	*1*	-	*1*
Difficulty in recruitment of supervisors	*(1)* Lim and Alum (1995)	*1*	-	-	-	-	*1*
High rate of labour turnover	*(3)* Lim and Alum (1995)	-	-	*1*	-	-	*1*
Shortage of power/water	*(2)* Gundecha (2012)	-	*1*	-	-	-	*1*
Subcontractor Problems	*(3)* Sambasivan and Soon (2007)	-	-	*1*	-	-	*1*
Project policies	*(4)* Dai and Goodrum (2011)	-	-	-	*1*	-	*1*
Use of technology	*(4)* Cooper (2005); Ailabouni et al. (2007)	-	-	-	*2*	-	*2*
Weather	*(3)* Muhammad et al. (2015) *(5)* Afolabi et al. (2018)	-	-	*1*	-	*1*	*2*
Government/politics related concerns	*(3)* Yi and Chan (2014) *(5)* Alaghbari et al. (2019)	-	-	*1*	-	*1*	*2*
Absenteeism at the worksite	*(4)* Lim and Alum (1995); *(5)* Makulsawatudom et al. (2004)	-	-	-	*1*	*1*	*2*
Labour strikes	*(2)* Yi and Chan (2014); *(4)* Soekiman et al. (2011)	-	*1*	-	*1*	-	*2*
Realistic goals	*(1)* Shoar and Banaitis (2019); *(2)* Hickson and Ellis (2014) *(3)* Cooper (2005)	*1*	*1*	*1*	-	-	*3*
Site layout	*(4)* Muhammad et al. (2015); *(5)* Kazaz et al. (2008); Gundecha (2012)	-	-	-	*1*	*2*	*3*
Buildability issues	*(3)* Naoum (2016); *(4)* Jang et al. (2011); Durdyev and Mbachu (2011)	-	-	*1*	*2*	-	*3*
Duration of work/ overtime works	*(1)* Ailabouni et al. (2007); Cooper (2005); *(2)* Maloney (1983); *(5)* Shoar and Banaitis (2019)	*2*	*1*	-	-	*1*	*4*
Lack of clarity in project scope	*(1)* Venkatesh and Saravana Natarajan (2019) *(5)* Doloi et al. (2012); Jarkas and Haupt (2015); Jarkas et al. (2015)	*1*	-	-	-	*3*	*4*
Work intensity/flow of work or material	*(1)* Maloney (1983); *(2)* Palikhe et al. (2019) *(3)* Kazaz et al. (2008); *(4)* Rami Huges (2014); *(5)* Robles et al. (2014)	*1*	*1*	*1*	*1*	*1*	*5*
Change orders	*(2)* Jarkas and Haupt (2015); Jarkas et al. (2015) *(3)* Abdul Kadir, Lee et al. (2005); *(4)* Jarkas and Radosavljevic (2013); *(5)* Enshassi et al. (2007)	-	*2*	*1*	*1*	*1*	*5*
Lack of commitment/motivation	*(1)* Doloi et al. (2012); Shashank et al. (2014); Odesola and Idoro (2014); Hiyassat et al. (2016); *(3)* Robles et al. (2014)	*4*	-	*1*	-	-	*5*
Difficulty in recruitment of workers	*(2)* Lim and Alum (1995); Shashank et al. (2014); *(3)* Bekr (2017); *(4)* Dixit et al. (2017) *(5)* Sambasivan and Soon (2007); Muhammad et al. (2015)	-	*2*	*1*	*1*	*2*	*6*
Late instructions	*(1)* Dixit et al. (2017); *(3)* Jarkas and Haupt (2015); Jarkas et al. (2015); Palikhe et al. (2019) *(4)* Abdul Kadir, Lee et al. (2005); *(5)* Mohammed and Isah (2012)	*1*	-	*3*	*1*	*1*	*6*
Rework	*(1)* Durdyev and Mbachu (2011); Rami Huges (2014); *(2)* Jarkas and Radosavljevic (2013); *(3)* Alinaitwe et al. (2007); Odesola and Idoro (2014); Shoar and Banaitis (2019)	*2*	*1*	*3*	-	-	*6*
Poor construction methods	*(1)* Ameh and Osegbo (2011); Ghoddousi and Hosseini (2012); *(3)* Jang et al. (2011); Durdyev and Mbachu (2011); Durdyev and Mbachu (2018); *(5)* Alinaitwe et al. (2007)	*2*	-	*3*	-	*1*	*6*
Safety/accidents	*(2)* Cooper (2005); *(3)* Gundecha (2012); *(4)* Shashank et al. (2014); Ohueri et al. (2018) *(5)* Kazaz and Acıkara (2015); Abdul Kadir, Lee et al. (2005); Choudhry (2015)	-	*1*	*1*	*2*	*3*	*7*
Incomplete drawings	*(1)* Jarkas and Haupt (2015); Jarkas et al. (2015); *(2)* Makulsawatudom et al. (2004); Naoum (2016); *(3)* Ameh and Osegbo (2011); Mohammed and Isah (2012); Thomas and Sudhakumar (2013); Rami Huges (2014)	*2*	*2*	*4*	-	-	*8*
Salaries/bonus/benefits on time	*(1)* Kazaz and Acıkara (2015); Momade and Hainin (2019); *(2)* Ohueri et al. (2018) *(3)* Ailabouni et al. (2007); Dai and Goodrum (2011); Jarkas and Radosavljevic (2013); *(4)* Afolabi et al. (2018); Palikhe et al. (2019) *(5)* Thomas and Sudhakumar (2013)	*2*	*1*	*3*	*2*	*1*	*9*
Default payments	*(1)* Jarkas and Radosavljevic (2013); *(2)* Abdul Kadir, Lee et al. (2005); Sambasivan and Soon (2007); *(3)* Afolabi et al. (2018) *(4)* Choudhry (2015); Shoar and Banaitis (2019); *(5)* Soekiman et al. (2011); Yi and Chan (2014); Dixit et al. (2017); Palikhe et al. (2019)	*1*	*2*	*1*	*2*	*4*	*10*
Work effectiveness/experience	*(1)* Liberda et al. (2003); Robles et al. (2014); Naoum (2016); Hiyassat et al. (2016); Choudhry (2017); Alaghbari et al. (2019) *(2)* Enshassi et al. (2007); Jang et al. (2011); Durdyev and Mbachu (2011); Li et al. (2016); *(3)* Maloney (1983); *(4)* Ghoddousi and Hosseini (2012)	*6*	*4*	*1*	*1*	-	*12*
Worker efficiency/ skills training	*(1)* Robles et al. (2014); Muhammad et al. (2015); Choudhry (2015); *(2)* Liberda et al. (2003); Alinaitwe et al. (2007); Odesola and Idoro (2014); Shoar and Banaitis (2019); *(3)* Hickson and Ellis (2014); Ohueri et al. (2018); Venkatesh and Saravana Natarajan (2019); *(4)* Maloney (1983) *(5)* Momade and Hainin (2019)	*3*	*4*	*3*	*1*	*1*	*12*
Communication/coordination problems/ misunderstanding	*(2)* Soekiman et al. (2011); Mohammed and Isah (2012); *(3)* Doloi et al. (2012); Choudhry (2015); *(4)* Enshassi et al. (2007); Momade and Hainin (2018) *(5)* Lim and Alum (1995); Cooper (2005); Jang et al. (2011); Durdyev and Mbachu (2011); Durdyev and Mbachu (2018); Naoum (2016); Venkatesh and Saravana Natarajan (2019)	-	*2*	*2*	*2*	*7*	*13*
Lack of material/ tools/equipment	*(1)* Makulsawatudom et al. (2004); Abdul Kadir et al. (2005); Enshassi et al. (2007); Soekiman et al. (2011); Gundecha (2012); Thomas and Sudhakumar (2013); Afolabi et al. (2018); Palikhe et al. (2019) *(2)* Kazaz et al. (2008); Dai and Goodrum (2011); Ameh and Osegbo (2011); Muhammad et al. (2015); Shan et al. (2016); Bekr (2017); Alaghbari et al. (2019) *(3)* Ghoddousi and Hosseini (2012); Shashank et al. (2014); *(4)* Sambasivan and Soon (2007); Alinaitwe et al. (2007); *(5)* Rami Huges (2014); Hiyassat et al. (2016)	*8*	*7*	*2*	*2*	*2*	*21*

(*continued*)

Table 2. Continued.

Factors	Rank by Researchers	1	2	3	4	5	∑
Incompetent supervisors/poor management and planning	***(1)*** Sambasivan and Soon (2007); Alinaitwe et al. (2007); Kazaz et al. (2008); Dai and Goodrum (2011); Mohammed and Isah (2012); Yi and Chan (2014); Jang et al. (2011); Shan et al. (2016); Bekr (2017); Durdyev and Mbachu (2018); Ohueri et al. (2018); Hickson and Ellis (2014) ***(2)*** Ailabouni et al. (2007); Ghoddousi and Hosseini (2012); Doloi et al. (2012); Rami Huges (2014); Shan et al. (2016); Dixit et al. (2017); Afolabi et al. (2018); Venkatesh and Saravana Natarajan (2019) ***(3)*** Makulsawatudom et al. (2004); Enshassi et al. (2007); Hiyassat et al. (2016); Alaghbari et al. (2019) ***(4)*** Jarkas and Haupt (2015); Jarkas et al. (2015); Naoum (2016); Odesola and Idoro (2014); ***(5)*** Ameh and Osegbo (2011); Jarkas and Radosavljevic (2013); Shashank et al. (2014)	***12***	***8***	***4***	***4***	***3***	***31***

Table 3. Identification of the factors related to CLP in different geographical regions.

Number of studies	Countries	Continent	Percentage of studies
1/48	Canada	**North America**	15%
5/48	USA		
1/48	Trinidad and Tobago		
1/48	Spain	**Europe**	13%
1/48	Lithuania		
2/48	UK		
2/48	Turkey		
4/48	Nigeria	**Africa**	10%
1/48	Uganda		
1/48	China	**Asia**	58%
1/48	Yemen		
1/48	Gaza		
5/48	India		
1/48	Iran		
1/48	UAE		
1/48	South Korea		
1/48	Indonesia		
1/48	Cambodia		
2/48	Jordan		
1/48	Kuwait		
1/48	Nepal		
4/48	Malaysia		
2/48	Qatar		
1/48	Oman		
1/48	Saudi Arabia		
1/48	Singapore		
1/48	Srilanka		
1/48	Thailand		
1/48	Australia	**Australia Pacific**	4%
1/48	New Zealand		

2014) and (5) Construction methods (Alinaitwe et al. 2007; Ameh and Osegbo 2011) are the critical occurring factors affecting CLP.

In South East Asia region and the Pacific, majority of the researchers have concluded that (1) Availability of equipment and material (Makulsawatudom et al. 2004; Abdul Kadir et al. 2005; Sambasivan and Soon 2007; Soekiman et al. 2011; Rami Huges 2014; Muhammad et al. 2015), (2) Supervision and Site Management (Makulsawatudom et al. 2004; Abdul Kadir et al. 2005; Rami Huges 2014; Durdyev and Mbachu 2018; Ohueri et al. 2018), (3) Payment Method and delay in payments (Abdul Kadir et al. 2005; Sambasivan and Soon 2007; Soekiman et al. 2011; Ohueri et al. 2018), (4) Communication (Lim and Alum 1995; Durdyev and Mbachu 2011; Soekiman et al. 2011; Durdyev and Mbachu 2018) and (5) Absenteeism from work (Lim and Alum 1995; Makulsawatudom et al. 2004; Soekiman et al. 2011) are the critical occurring factors affecting CLP.

In Far East and Central Asia region, majority of the researchers have concluded that (1) Supervision/ Site Management (Ailabouni et al. 2007; Enshassi et al. 2007; Jang et al. 2011; Doloi et al. 2012; Ghoddousi and Hosseini 2012; Jarkas and Radosavljevic 2013; Shashank et al. 2014; Jarkas 2015; Jarkas and Haupt 2015; Venkatesh and Saravana Natarajan 2019), (2) Availability of equipment and material/Delay of material (Enshassi et al. 2007; Ghoddousi and Hosseini 2012; Thomas and Sudhakumar 2013; Shashank et al. 2014; Hiyassat et al. 2016; Bekr 2017; Dixit et al. 2017; Alaghbari et al. 2019; Palikhe et al. 2019), (3) Payment on time/ Low pay (Ailabouni et al. 2007; Jarkas and

Radosavljevic 2013; Thomas and Sudhakumar 2013; Choudhry 2015; Dixit et al. 2017; Palikhe et al. 2019), (4) Worker skills/experience (Enshassi et al. 2007; Ghoddousi and Hosseini 2012; Hiyassat et al. 2016; Li et al. 2016; Choudhry 2015; Alaghbari et al. 2019) and (5) Poor Planning (Jang et al. 2011; Doloi et al. 2012; Hiyassat et al. 2016; Bekr 2017; Dixit et al. 2017; Venkatesh and Saravana Natarajan 2019) are the critical occurring factors affecting CLP.

From the studies made on geographical regions, we can conclude that construction productivity is one of the significant aspects that need to be measured, evaluated and discussed based on geography. It can be noted that there is a large research gap as no study to date has been conducted in South America and very few in Africa. Studies in the South American continent can further assist the construction project management to develop a wider and deeper perspective of the motivational factors impacting the performance and to provide project managers with guidance for focusing, acting upon, and controlling the critical factors influencing the productivity.

A distinct discrepancy in the findings can be noted based on the geographical regions. In North America and Europe, where the researched countries can be classified as developed nations, the important CLP factors are mostly related to project execution works: (1) Sharing of equipment/machinery not available (Dai and Goodrum 2011; Gundecha 2012), (2) Management & planning, and poor supervision (Dai and Goodrum 2011; Yi and Chan 2014), (3) Financial incentives (Dai and Goodrum 2011; Yi and Chan 2014), (4) Worker efficiency (Maloney 1983; Liberda et al. 2003) and (5) Unrealistic schedule (Cooper 2005; Shoar and Banaitis 2019). On the contrary, in developing and third world nations in Africa and Asia, the important CLP factors are mostly labour/material related problems such as (1) Availability of equipment and material/Delay of material (Enshassi et al. 2007; Ghoddousi and Hosseini 2012; Thomas and Sudhakumar 2013; Shashank et al. 2014; Hiyassat et al. 2016; Bekr 2017; Dixit et al. 2017; Alaghbari et al. 2019; Palikhe et al. 2019), (2) Payment on time/Low pay (Ailabouni et al. 2007; Jarkas and Radosavljevic 2013; Thomas and Sudhakumar 2013; Choudhry 2015; Dixit et al. 2017; Palikhe et al. 2019), (3) Worker skills/experience (Enshassi et al. 2007; Ghoddousi and Hosseini 2012; Hiyassat et al. 2016; Li et al. 2016; Choudhry 2015; Alaghbari et al. 2019) and (4) Absenteeism from work (Lim and Alum 1995; Makulsawatudom et al. 2004; Soekiman et al. 2011). The result indicates that the possible reasons for such variance in CLP factors in different geographical regions could be due to: (1) developed countries are focusing on improving the work efficiency and are not completely dependent on the labour for the execution works as technology plays an important role in completing the works; (2) developing countries do not have sufficient funds and technology benefits and therefore depend highly on the workers to complete the works.

Finding no 3: Method of research on CLP factors

The procedure followed for the assessment of factors related to CLP in different research mainly consists of six steps. The steps are outlined below.

Stage 1 ***(Literature review)*** – in order to determine the major research outputs published in journals for the chosen topics, the researchers adopted similar methodology to those employed by (Al-Sharif and Kaka 2004; Tsai and Lydia Wen 2005; Ke et al. 2009; Hong et al. 2012; Jarkas and Radosavljevic 2013; Thomas and Sudhakumar 2013; Robles et al. 2014; Naoum 2016; Dixit et al. 2019; Shoar and Banaitis 2019). These topics were chosen on the basis of previous literature in the related fields and their link with CLP.

Stage 2 ***(Identification of CLP factors)*** – following on from the literature review, data from a survey was analysed by different researchers to show the factors impairing CLP. The factors were listed and categorized by respective researchers and inserted into a questionnaire for survey and data collection (Abdul Kadir et al. 2005; Alinaitwe et al. 2007; Jarkas and Radosavljevic 2013; Thomas and Sudhakumar 2013; Robles et al. 2014; Shashank et al. 2014; Naoum 2016; Shoar and Banaitis 2019).

Stage 3 ***(Pilot Test)*** – little survey was piloted on a small scale in order to ensure the questionnaire's readability, accuracy and comprehensiveness to the participants (Jarkas and Radosavljevic 2013; Thomas and Sudhakumar 2013; Robles et al. 2014; Palikhe et al. 2019).

Stage 4 ***(Data Collection)*** – Questionnaire survey was used as the medium for data collection (Abdul Kadir et al. 2005; Alinaitwe et al. 2007; Ameh and Osegbo 2011; Jarkas and Radosavljevic 2013; Robles et al. 2014; Shashank et al. 2014; Naoum 2016; Afolabi et al. 2018; Palikhe et al. 2019).

Stage 5 ***(Data analysis)*** – The data collected were analysed using simple percentages, mean scores, mean item scores, reliability (Cronbach's Alpha) and

regression analysis to develop a predictive model that will determine the impact of time overrun and labour productivity on construction sites (Abdul Kadir et al. 2005; Alinaitwe et al. 2007; Ameh and Osegbo 2011; Shashank et al. 2014; Shoar and Banaitis 2019). The data collected were analysed using the relative importance index (RII) technique in many studies (Jarkas and Radosavljevic 2013; Thomas and Sudhakumar 2013; Robles et al. 2014; Naoum 2016; Bekr 2017; Golnaraghi et al. 2019; Palikhe et al. 2019). Factor Analysis tests (Kaiser Meyer Olkin & Bartlett's Test of sphericity) were conducted in few studies (Thomas and Sudhakumar 2013; Shashank et al. 2014).

Stage 6 ***(Conclusions derived)*** – Discussion is made on the highest ranked within the category of overall ranking (Alinaitwe et al. 2007; Jarkas and Radosavljevic 2013; Thomas and Sudhakumar 2013; Shashank et al. 2014; Palikhe et al. 2019).

Finding no. 4: Research on labour's opinion to improve CLP

Managerial/Executive's opinion on the CLP factors has been researched comprehensively; however, there is a very little research on the opinion of the labourer's on CLP factors (Rivas et al. 2011, Thomas and Sudhakumar 2013). One of the major finding of the present research is that there is minimum research conducted on 'labour's' perspective for construction productivity. Labour forms more than 80% of project team and costs 40% of total project cost (Sherekar et al. 2016). Yet, little research on their opinion. A number of researchers stressed the necessity of obtaining the perception of the craftsmen also on factors influencing productivity, as the craftsmen working in the field tend to be more aware of productivity problems (Chan and Kaka 2007; Dai and Goodrum 2011; Rivas et al. 2011; Thomas and Sudhakumar 2013).

The relation among their age, character, experience, nationality could potentially hold the mystery to their performances. Individual behaviour studies of 'Good Workers/Bad Workers' in terms of work performance could further reveal the key elements to identify when recruitments are carried out. Workers are commonly hired in groups for large project sites from agents (worker suppliers). Further research in this direction will help to classify and minimize the hiring of low productive workers. The government regulations and policies in worker hiring quota can also follow the hiring pattern and direction to improve productivity.

The present research is of the opinion that a top down approach will always keep the construction firm's objectives a priority over those which are of construction labourer's. For instance, factors which may influence spending on well-being of worker (health, residence, education) may be directly seen as unnecessary expenses. Though, the rise of any percentage of labour productivity is a direct raise in profit for all construction firms/contractors.

Finding no. 5: Recommendations to improve CLP

The recommendations made in different studies to improve CLP were also identified. The major recommendations made by different researchers are outlined below.

Structured training for all construction workers and supervisors

Most of the previous studies emphasize on the need for the training of construction of workers and supervisors to improve CLP (Abdul Kadir et al. 2005; Alinaitwe et al. 2007; Robles et al. 2014; Choudhry 2015; Ohueri et al. 2018; Shoar and Banaitis 2019). Abdul Kadir et al. (2005) mentioned that the construction industry and the government should take proactive measures to train and encourage local people to join the construction industry. The level of supervision and level of skills of craftsmen particularly have to be improved. Contractors should focus on improving these areas by giving refresher courses, rewarding on the basis of skill and output, and participating in structured training on workers in the construction industry (Alinaitwe et al. 2007; Choudhry 2015). The project manager of construction companies should increase their leadership skill and the labour skill in the project by appropriate training program. It becomes necessary to conduct training courses and seminars in management topics for the site managers, on the other hand, contractors should provide strong assistance and support regarding the continual training of their labourer (Robles et al. 2014). Governmental policy should encourage and pay more attention to formal technical education and trainee programs as such support can enhance and boost the construction industry and the overall economy of the country (Alaghbari et al. 2019; Palikhe et al. 2019). Contractors and subcontractors should ensure adequate training and supervision of the operatives as it improves the quality of output as well as

minimize the chances of doing wrong work or even application of wrong construction method by the workers (Ameh and Osegbo 2011; Ghoddousi and Hosseini 2012; Odesola and Idoro 2014; Rami Huges 2014; Durdyev and Mbachu 2018). A number of studies (Jayawardane and Gunawardena 1998; Card 1999; Heng et al. 2006; Sofia Lopes and Teixeira 2013) showed that there is a positive relationship between earnings and training participation for blue collar workers, which indicates an increase in productivity through training.

Increasing labour benefits

A number of previous studies highlighted the necessity of the improvement of labour commitment and the relationship among workers by increasing labour benefit, satisfaction and team building program (Ailabouni et al. 2007; Alinaitwe et al. 2007; Dai and Goodrum 2011; Odesola and Idoro 2014; Shashank et al. 2014; Choudhry 2015; Durdyev and Mbachu 2018; Ohueri et al. 2018). Financial incentives has a positive correlation with worker motivation and is an important way to satisfy the basic need of the labours (Afolabi et al. 2018; Palikhe et al. 2019).

Management techniques and communication

To ease the variation of labour productivity, the construction companies should improve supervision by implementing periodic meeting and ensure supervisors/project managers were correctly selected (Jarkas and Radosavljevic 2013; Shashank et al. 2014). Planning software should be used in the project to have a proper planning of the work to reduce the frequency of working overtime. Material delay and material arrangement, tool and equipment management should be improved by adopting proper material management system. (Ameh and Osegbo 2011; Ghoddousi and Hosseini 2012; Shashank et al. 2014; Afolabi et al. 2018; Hasan et al. 2018; Seddeeq et al. 2019). It is also significant to promote the function of effective management of labours and human resources as this could lead to successful management of construction projects and initiatives (Alaghbari et al. 2019).

Lean techniques could be implemented in order to improve labour productivity and also help contractors and construction managers for the effective management of the labour forces (Robles et al. 2014). These concepts are, after all, directed toward eliminating waste, minimizing the transaction cost as well as the enhancement and transfer of shared knowledge and expertise among all parties (Naoum 2016).

It is highly recommended to use project scheduling techniques (such as computer-aided construction project management) during the construction phase to optimize the times of related activities and to ensure that work allow continuous task performance and hence, reducing idleness of the labour force to a minimum. Communication problems between site management and workers and also between crews may be mitigated through all-foreman meetings (Ghoddousi and Hosseini 2012; Rami Huges 2014; Robles et al. 2014; Dixit et al. 2017). According to Naoum (2016), the main principle of a Quality of working life (QWL) is to change the climate or the culture of the work place by allowing people to be more involved in the production process; improvement of environmental conditions; increasing the flow of communication within the work place and better leadership styles and interpersonal relationships. A number of studies (Alinaitwe et al. 2007; Dai and Goodrum 2011; Thomas and Sudhakumar 2013; Alaghbari et al. 2019) has stated that proactive measures by the management to control the factors identified have helped to achieve significant productivity improvement on the construction projects

Minimize the change of orders

The findings of previous studies clearly indicate that minimizing change is important for realizing good cost, schedule and productivity performance (Ibbs 2012; Jarkas and Haupt 2015; Durdyev and Mbachu 2018; Shoar and Banaitis 2019). By avoiding interruptions during the construction phase, project teams can reduce the probability of disputes and costly litigations and claims while instead maintaining healthy business relationships through successful and timely project delivery (Griego and Leite 2017). The designing team should also be quite experienced to avoid revised drawings (Rami Huges 2014; Shashank et al. 2014). Procurement methods that allow the involvement of contractors during the design stage of projects, such as design/build (DB), design/build/operate/transfer (DBOT) or turnkey/engineering, procurement and construction (EPC), and thus accelerate the incorporation of the construction experience at the early stage of the project development process so that the desired benefits can be achieved during the construction phase (Robles et al. 2014). A number of studies (Moselhi et al. 1991, 2005; Seddeeq et al. 2019) showed that time

and cost overrun of projects can be reduced by minimizing change orders, which in turn can contribute significantly to the productivity.

Automation & technological advancements/use of offsite manufacturing

The findings of the previous studies clearly indicate that the adoption of technologies have a strong impact in raising levels of productivity in construction projects (Azman et al. 2019). Considering the increasing use of technology in construction projects along with recent advancements in the field of robotics, drones, automation, virtual reality and remote sensing, it is important to identify technology as a basic factor affecting productivity in construction projects (Hasan et al. 2018). Besides offsite manufacturing can improve the productivity significantly. Some of the benefits of offsite manufacturing are: (1) discounted material prices for manufacturers save on construction project costs; (2) less time spent for a construction project provides further cost savings; (3) reduced amount of rework can eventually save on construction project costs and productivity (Durdyev and Ismail 2019). Studies reported that the use of technology in construction has raised the work efficiency and improve productivity (or savings) in man-days of at least 78% (Alaghbari et al. 2019; Zhiqiang et al. 2019). Besides, material wastage was reduced and less reliance was placed on migrant workers, which helped to mitigate the social concerns created by the influx of foreign workers (Zhiqiang et al. 2019).

Conclusion

A thorough literature review has been conducted in this research for the identification of the factors related to CLP in order to recommend the measures required to improve CLP. The survey is based on literature review only and thus, limited to past research conducted on this topic and covers the recent research journals available. No questionnaires/interviews were held with industry experts to seek their opinion on this matter. The conclusions can be made from the study are summarized below.

There are many challenges facing the construction industry, but one of the most significant is low productivity. The CLP significantly influences the profitability of construction companies; however, CLP exhibits the highest variability among project resources and is a major source of project risk. Understanding critical factors that affect labour productivity can help to develop strategies to reduce inefficiencies and to more effectively manage construction labour forces. This will not only improve the project performance of construction companies, but also make them more competitive and consequently increase the chances of survival within this highly competitive sector.

The present study identified five factors namely, incompetent supervisors/poor management and planning, lack of materials/tools/equipment, work effectiveness/experience, lack of commitment/motivation and worker efficiency/skills as most importantly related to CLP. The outcomes can help practitioners to develop a wider and deeper perspective of the factors influencing the productivity of operatives and to provide guidance to construction project managers for the efficient utilization of the labour force

Further research shall be conducted in the following direction to look further into CLP and its factors: (1) workers' opinion in identification of CLP for residential/industrial construction projects; (2) review of CLP models and its impact on construction labour productivity; (3) essential skills/abilities to upgrade worker productivity levels.

Disclosure statement

No potential conflict of interest was reported by the authors.

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