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Impact of Labour Productivity Factors on Construction Project Cost and Time

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Abstract
Productivity is the dominating aspect in construction as it encourages cost savings and effective utilization of resources. Poor labour productivity is one of the major causes of cost and time overrun in construction projects and as such requires attention. Previous studies have identified factors affecting labour productivity within building projects, however, there is need to understand these factors as it relates to their impact on cost and time. In view of this, the paper aimed at assessing the impact of factors affecting labour productivity on cost and time, with a view to minimizing their effects on construction projects. The study elicits knowledge gained by project managers actively engaged in construction projects within Abuja been the Federal Capital Territory and employed the use of a survey. A well-structured questionnaire was designed to collect data with respect to degree of impact of labour productivity factors on construction project cost, and time using a five-point Likert scale and distributed to 45 project managers using purposive sampling. Responses from the administered questionnaires were collated, interpreted, and analysed using descriptive statistics, and results presented in tables. The findings showed that material shortage at project site with a mean value of 3.68 had significant impact on construction project cost. Furthermore, lack of tools and equipment in the market, and workforce absenteeism with mean values of 3.65 and 3.62 respectively had significant impacts on construction project time. The study concludes that material shortage, lack of tools and equipment in the market, and workforce absenteeism are labour productivity factors that had significant impact on construction project cost and time. Thus, Construction managers should enforce the use of material supply schedule, and adopt appropriate financial incentives for employee's that could curtail the problem of absenteeism.

Keywords: Construction Project, Cost Overrun, Labour Productivity, Project Manager, Time Overrun.

Introduction
The construction industry plays an important role in any developing country. This sector promotes the infrastructure required in socioeconomic development which is a major contributor to the overall economic growth (Abdul Karim *et al.*, 2012; Attar *et al.*, 2012; Hafez *et al.*, 2014). It contributes by supplying the infrastructure and physical structures of a country to house other industries, creating jobs, contributing to a country's Gross Domestic Product (GDP), and providing basic needs such as housing (Wibowo, 2009). The industry is highly dynamic such that risks, and uncertainties are inherent more than any other industries (Ofori, 2015).

According to Ayangade (2009), the contribution of the Nigerian construction industry is yet to measure up to those of the western world like the UK and Australia due to its developing nature. As noted by the same researcher (Ayangade, 2009), whereas the construction industries of other developed countries are responsible for about 22% of their respective GDP's, the Nigerian case is different as it contributes slightly below 16% to its economy. However, this could be said to be complemented by the relatively higher employment (20%) it provides for its whooping 140 million citizens compared to the 12% as in the case of developed countries. Mbamali (2012) attributed this to relatively lower use of mechanization within construction in Nigeria and the high dependency of the Nigerian economy on the oil sector.

If the construction sector and the economy of a country are so closely linked, then it makes sense to effectively manage the human resources within that industry (James *et al.*, 2012). Construction works are often capital intensive, have a long payback period, with many associated risks and uncertainties (Lawal *et al.*, 2021).

Pornthepkasemsant and Charoenpornpattana (2019); Attar *et al.* (2012); Abdul Karim *et al*. (2012) agrees that construction labour productivity is one of the major elements of every company success and competiveness, which is mainly associated with labour performance. Labour cost is an important part of project cost as it includes almost 30-50% of overall cost (Jarkas and Bitar, 2012).
According to Kisi *et al.* (2018), Krishna *et al.* (2017), Mahamid *et al.* (2013) labour productivity plays a key role in determining the success of a project. However, it might be affected by many extrinsic variables. These variables may include factors related to labour, materials, tools and equipment, construction methods, political, financing and environment. Poor labour productivity is one of the main causes of cost and time overruns in construction projects and as such, deserves the attention of researchers in the construction industry (Kermanshachi *et al.*, 2021; Famiyeh *et al.*, 2017; Ameh and Osegbo, 2011). As the construction industry undertakes complex and innovative projects, improving the labour productivity that helps accomplish the triple bottom line dimensions (time, schedule and performance) assumes greater importance (Chaturvedi *et al.*, 2018).

Adebowale and Agumba (2021), Mahamid *et al*. (2013) noted that improving labour productivity is a major concern to the construction industry if good and efficient output is to be achieved. In light of this, there is a need to study labour productivity factors and its impact on cost and time. Enshassi, Mohamed, Mustafa and Mayer (2007) identified factors affecting labour productivity within building projects, and ranked these factors according to their relative importance from a contractor's viewpoint. However, no attempt was done to relate these factors to its effect on cost and time. Understanding the impact of labour productivity factors on project cost, and time would improve the management, and control of project cost, and time. Furthermore, the study would assist project managers in the allocation of limited resources to address labour productivity factors that would yield greater output. Hence, the need to critically examine these labour productivity factors and determine their impact on construction project cost and time. The research only measured impact of labour productivity factor on two project objective (cost and time), other project objectives were not considered.

Over the years, considerable research efforts of Pornthepkasemsant and Charoenpornpattana (2019), Durdyev *et al.* (2018), Rivas *et al.* (2011), Dai *et al.* (2009), Kazaz *et al.* (2008), have been devoted to investigating the factors limiting construction labour productivity. Most of those researches reported country-specific productivity limiting factors, and the differences are driven by sociocultural, legislative, and regulatory environments within which construction operations are undertaken. In Malaysia, the various factors that affect labour productivity performance, based on an in-depth review of the relevant literature by Durdyev and Mbachu (2017) can generally be categorized into five areas, called the 5Ms, namely, management (method), money, manpower (i.e., workforce), materials, and machinery. It is further hypothesized that the latent factors (along with the key associated attributes), namely, management and control (MC), workforce(W), finance(F), project(P), material and equipment (ME), and external (E) influence the ability to achieve higher levels of labour productivity in the construction context of Malaysia. Factor affecting labour productivity as highlighted by various authors was reviewed and grouped under the following headings as indicated in Table 1.

Table 1: Factors Affecting Labour Productivity

S/No.	Codes	Factors	Sources
	A	**MANAGEMENT AND CONTROL**	
1	A1	Supervision, performance monitoring, and control	Doloi *et al*. (2012), Dai *et al.*
2	A2	Competencies of the project manager	(2009), Huang *et al*. (2008), Ibbs
3	A3	Loss in productivity caused from change orders	*et al.* (2007) Dainty *et al*, (2005),
4	A4	Lack of capability of contractor's site management to organize on-site works	Bernold and AbouRizk (2010), and
5	A5	Adequacy of planning and risk management process	Ghoddousi and Husseini (2012).
6	A6	Adequacy of method of construction	
7	A7	Project management style	
8	A8	Lack of coordination among the construction parties	
9	A9	Relationship management/degree of harmony, trust, and cooperation	
10	A10	Project organizational culture	
	B	**WORKFORCE**	Kazaz and Ulubeyli
11	B1	Level of skill and experience of the workforce	(2004), Hanafi *et al*.
12	B2	Level of motivation/commitment of the workforce	(2010), Durdyev *et al*.
13	B3	Inadequate site staff	(2013), Bernold and
14	B4	Level of familiarity with current job and conditions	AbouRizk (2010), and
15	B5	Workforce absenteeism	Mojahed and Aghazadeh (2008).
16	B6	Level of empowerment (training and resourcing)	
17	B7	Lack of training and education to implement and operate new technologies	
18	B8	Level of involvement of direct labor or subcontract	
	C	**FINANCE**	
19	C1	Inadequate supply or high cost of resources: workers, materials, machinery, and money	Forsberg (2007), Page (2010), Jarkas and
20	C2	Level of staff turnover/churn rate	Bitar (2012), Durdyev
21	C3	Reworks because of on-site construction errors	and Mbachu (2017), and Love
22	C4	Inflation/fluctuations in material prices	and Edwards, (2005).
23	C5	Fluctuations in exchange rate	
24	C6	Late payments	

	D	**PROJECT**	
25	D1	Site conditions, access, subsoil, topography, and traffic	Jarkas (2010) and Durdyev and
26	D2	Ground conditions necessitating revisions	Mbachu (2011)
27	D3	Project complexity: scale and design	
28	D4	Poor buildability design	
	E	**MATERIAL AND EQUIPMENT**	
29	E1	Lack of tool and equipment in the market	Alonso et al. (2007), Pratibha
30	E2	Suitability or adequacy of the plant and equipment used	and Gaikwad
31	E3	Adequacy of technology used	(2015), Kazaz *et al.*
32	E4	Late supply of construction materials	(2008), and Page (2010).
33	E5	Material shortage at project site	
	F	**EXTERNAL**	
34	F1	Poor weather conditions	Ghoddousi and Hosseini (2012),
35	F2	Slow local authority approval	Moselhi and
36	F3	Stop work order because of infringement of government regulation	Khan (2010), Durdyev et al. (2017), and
37	F4	On-site accidents/acts of God	Ratcliffe and Stubbs
38	F5	Unrealistic deadline for project completion set by client	(2003).
39	F6	Client's over influence on the construction process	

Adapted from (Durdyev *et al.*, 2018).

Cost overrun occurs when the expenses required to complete a project exceed the amount budgeted (Endut *et al.*, 2009). Cost overrun is also sometimes called "cost escalation," "cost increase," or "budget overrun." (Al-Najjar, 2008). Cost overruns in construction projects are not uncommon all over the world (Olawale and Sun, 2010). Cost overruns, whether they are due to delay or estimation errors or any other factors, do not just happen, they are caused (Maieli, 2001). The cost of construction project is affected by a large number of factors (Chan and Park, 2005). Eden *et al.* (2005) illustrated that the growth in project cost is "amoebic" in nature. According to them, it is not easy to track down what drives total cost overrun. They suggested it tends to spread in an amoebic manner. They also stated that project costs escalate in an exponential manner and not linearly. Table 2 is a scale for assessing cost overrun as used by Roetzhiem (1988) and adopted for this study

Table 2: Likert Scale on Degree of Impact on Cost.

Score	Level of impact	Description
1	Low	Within budget
2	Minor	1-10% cost increase
3	Moderate	11-25% cost increase
4	Significant	26-50% cost increase
5	High	Cost increase in excess of 50%

Subramani (2014) defined time overrun as the extension of time beyond planned completion date specified in contract or beyond the date that parties agreed upon for delivery of project. Bramble and Callahan (2007) describe time overrun as the time during which some part of construction project is completed beyond the project completion date or not performed as planned due to an unanticipated circumstance. Delays are incidents that impact a project's progress and postpone project activities. In general, project delays occur as a result of project activities that have both external and internal cause and effect relationship (Vidalis, 2002). Table 3 is a scale for assessing time overrun as used by Roetzhiem (1988) and adopted for this study

Table 3: Likert Scale on Degree of Impact on Time

Score	Level of impact	Description
1	Low	Negligible impact compensated by scheduled slack time
2	Minor	Minor slip less than 1 month
3	Moderate	Moderate slip 1-3 month
4	Significant	Significant slip greater than 3 months
5	High	Large schedule slip

Methodology

The study determined the impact of labour productivity factors on two major project objectives (cost and time). This requires eliciting knowledge from project managers who are directly involved in construction projects, and usually the head of the project team expected to do all that is required to meet up with the project objectives. Hence, a quantitative research approach was adopted involving the use of questionnaire. The questionnaire contained two sections of close ended questions. Section A are questions bordering on the background information of the respondents and section B are questions aimed at assessing the impact of labour productivity factors on project cost and time using a five-point likert scale of 1(low impact) to 5(high impact). Population size for the research is unknown as no data is available on exact number of project managers practicing in Abuja. The sample size was determined from a table developed by Louangrath (2014) that the minimum sample size for an unknown population for 95% confidence interval with 5% allowable error is approximately 34. A total of 45 questionnaires were

distributed amongst project managers in Abuja using purposive sampling technique, where the nature of projects previously handled, and years of experience of the respondents were of major concern. However, only 37(82.2%) questionnaires were analysed using descriptive statistics. Frequency was used to analyse the responses, mean was used to get the average score of the impact, and standard deviation used to measure the level of dispersion especially for factors having similar mean. The results for the study were presented in tables.

Results and Discussion

Respondent's profile

The respondent's profile which includes nature of job mostly handled and years of experience are presented in Table 4.

Table 4: Respondents Profile

Items	Frequency (No.)	Percentage (%)
Nature of project mostly handled		
large construction project	9	24.3
medium construction project	21	56.8
small construction project	7	18.9
Total	**37**	**100.0**
Years of experience		
1-5	12	32.4
6-15	17	45.9
16-25	5	13.5
Above 25	3	8.2
Total	**37**	**100.0**

Table 4 indicates that 18.9% of the respondents had handled small construction projects. A cumulative of 81.1% of the respondents had handled both large and medium construction projects. This implies that a larger percentage of the respondents have experience in handling large, and medium construction projects making it easier for them to provide better perception about the subject matter of the study. Also, the Table shows that 32.4% of the respondents had between 0-5 years of experience while a cumulative of 67.6% of the respondents indicating a larger percentage of the respondents had at least 5 years of experience handling construction projects which is usually a required minimum for project managers in most developing countries, depending on the work requirement. The experience gained would aid the project managers provide better insight or perception about the subject of discussion in the study.

Impact of factors affecting labour productivity on construction project cost

The impact of each factor affecting labour productivity on construction project cost were rated by respondents based on a five-point Likert scale of 1 (low impact) to 5 (high impact) as adopted by Roetzheim (1988) and shown in Table 2. Mean values and standard deviation were used to rank the factors as shown in Table 5.

Table 5 present the assessment of the impact of each factor affecting labour productivity on construction project cost which shows that the most significant factor is "Material shortage at project site" with a mean value of 3.68 while the least significant factor is "adequacy of technology used" with a mean value of 2.05. These results have proven once again that all the factors affecting labour productivity have impact on project cost as previously stated by (Mahamid *et al*, 2013).

Table 5: Comparison of Mean Values of Labour Productivity Factors on Construction Cost

Codes	Factors	Mean	S. D	Rank
E1	Material shortage at project site	3.68	1.454	1st
E2	Late supply of construction materials	3.38	1.421	2nd
D1	Site condition	3.32	1.270	3rd
C1	Inflation in material prices	3.24	1.442	4th
A1	Supervision, performance, monitoring and control	3.16	1.444	5th
F1	Poor weather condition	3.16	1.675	6th
B1	Inadequate site staff	3.14	1.273	7th
B2	Workforce absenteeism	3.00	1.247	8th
C2	Inadequate supply of resources	2.92	1.479	9th
B3	Level of empowerment	2.89	1.265	10th
A2	Adequacy of method of construction	2.89	1.329	11th
A3	Loss of productivity caused from change orders	2.84	1.236	12th
A4	Project management style	2.84	1.365	13th
A5	Project organizational culture	2.81	1.391	14th
A6	Competencies of the project manager	2.78	1.377	15th
C3	Fluctuation in exchange rate	2.71	1.460	16th
B4	Lack of training	2.70	1.431	17th
C4	Rework	2.68	1.292	18th
C5	Level of staff turnover	2.68	1.313	19th
A7	Relationship management	2.68	1.435	20th
B5	Level of skills and experience of labour	2.65	1.136	21st
B6	Level of involvement	2.59	1.166	22nd
C6	Late payment	2.59	1.212	23rd
B7	Level of motivation	2.59	1.384	24th
B8	Level of familiarity with current job	2.59	1.404	25th
A8	Adequacy of planning and risk management	2.57	1.345	26th
D2	Ground condition	2.51	1.070	27th
D3	Project complexity	2.49	1.096	28th
A9	Lack of coordination	2.49	1.304	29th
F2	Slow local authority approval	2.46	1.169	30th
A10	Capability of contractor	2.46	1.366	31st
F3	Stop work order	2.43	1.042	32nd
D4	Poor buildability design	2.41	1.092	33rd
F4	On-site accident	2.38	1.187	34th
E3	Lack of tools and equipment in market	2.35	1.160	35th
F5	Unrealistic deadline	2.30	1.051	36th
E4	Suitability of plant used	2.22	1.004	37th
F6	Clients over influence	2.19	0.776	38th
E5	Adequacy of technology used	2.05	0.776	39th

Material shortage being the most significant factor affecting cost is in line with previous research findings (Bageis and Fortune, 2009; Ameh *et al.,* 2010; Singh, 2011; Mahamid and Bruland, 2011; Alfouzan, 2013; Shaqour, 2014; Khodeir and Hamdy, 2015; Shanmuga and Baskar, 2015; Yakoub, 2016; Mostafa *et al.*, 2016) that material shortage is a major factor leading to cost overrun in developing countries and

could be attributed to fluctuations in the prices of building materials, shortage of construction material in the market and problems peculiar with some materials.

Table 6: Comparison of Mean Values across the Categories of Labour Productivity Factors on Construction Cost

Codes	Factor categories	Average Mean	Rank
C	Finance	2.83	1st
B	Workforce	2.77	2nd
A	Management and control	2.75	3rd
E	Material and Equipment	2.74	4th
D	Project	2.69	5th
F	External	2.49	6th

Table 6 indicates the mean of each category of labour productivity factors as they impact on construction project cost which shows that finance is the most influential with mean of 2.83. This is closely followed by workforce, management and control, material and equipment, project and external groups. It can be noticed that little variation exists in the mean values for all the categories except for external group that had 2.49 as the mean. The slight variation may be as a result of the agreement of researchers that all labour productivity factors have impact on project cost (Mahamid *et al.*, 2013). The external group factor ranking least amongst other factor categories supports previous research finding that external factors such as Unpredictable weather conditions and unsuitable climate to work are not very important factors for cost overrun occurrence (Singh, 2011; Doloi, 2013; Mostafa *et al.*, 2016).

Impact of factors affecting labour productivity on construction time

The impact for factors affecting labour productivity on construction time were rated by respondents based on a five-point Likert scale of 1 (low impact) to 5 (high impact) as adopted by Roetzheim (1988) and shown in Table 3. Mean values and standard deviation were used to rank the factors in Table 7.

Table 7 indicates impact of the factors affecting labour productivity on construction project time which shows that "lack of tools and equipment in market" and "workforce absenteeism" with a mean value of 3.65 and 3.62 respectively had significant impact on construction project time, while "unrealistic deadline" with a mean value of 2.32 was the least factor with a minor impact. Again, these results have supported Mahamid *et al.* (2013) proposition that labour productivity factors lead to time overrun in construction project as all labour productivity factors examined in this study had impact on construction project time although at varying degrees. High cost of machineries and lack of equipment in the market are reasons given by (Memon *et al.*, 2011; Toh, 2012; Abdul-Rahman *et al.*, 2013) for cost overrun which has been seen also as major contributors to time overrun. Absenteeism could lead to delay in the execution of tasks during construction process thereby leading to low productivity. These could be as a result of poor wages, attitudes and general working conditions (Mahdi *et al.*, 2011).

Table 7: Comparison of Mean Values of Labour Productivity Factors on Construction Time

Codes	Factors	Mean	S. D	Rank
E1	lack of tools and equipment in market	3.65	1.438	1st
B1	workforce absenteeism	3.62	1.479	2nd
F1	poor weather conditions	3.38	1.479	3rd
B2	inadequate site staff	3.32	1.334	4th
A1	loss of productivity caused from change orders	3.27	1.427	5th
C1	late payment	3.24	1.553	6th
D1	site condition	3.08	1.278	7th
A2	adequacy of planning and risk management	3.05	1.563	8th
C2	inflation in material prices	2.89	1.468	9th
E2	late supply of construction materials	2.84	1.259	10th
A3	Adequacy of method of construction	2.84	1.280	11th
E3	material shortage at project site	2.84	1.323	12th
A4	project organizational culture	2.84	1.385	13th
B3	level of empowerment	2.81	1.266	14th
A5	supervision, performance, monitoring and control	2.81	1.450	15th
A6	project management style	2.78	1.294	16th
F2	on-site accident	2.73	1.326	17th
F3	clients over influence	2.70	1.266	18th
C3	inadequate supply of resources	2.70	1.412	19th
C4	fluctuation in exchange rate	2.68	1.313	20th
A7	relationship management	2.68	1.375	21st
B4	lack of training	2.68	1.415	22nd
D2	ground condition	2.65	1.207	23rd
D3	project complexity	2.65	1.230	24th
C6	Reworks	2.62	1.277	25th
C5	level of staff turnover	2.62	1.341	26th
B5	level of skills and experience	2.59	1.166	27th
D4	poor buildability design	2.59	1.212	28th
F4	stop work order	2.59	1.257	29th
A8	competencies of the project manager	2.59	1.363	30th
B6	level of involvement	2.57	1.094	31st
E4	suitability of plant used	2.49	1.216	32nd
A9	lack of coordination	2.46	1.282	33rd
B7	level of motivation	2.46	1.304	34th
A10	capability of contractor	2.43	1.324	35th
E5	adequacy of technology used	2.41	1.257	36th
B8	level of familiarity with current job	2.38	1.277	37th
F6	slow local authority approval	2.32	1.002	38th
F5	unrealistic deadline	2.32	1.203	39th

Table 8: Comparison of Mean Values across the Categories of Labour Productivity Factors on Construction Time

Codes	Factor categories	Average Mean	Rank
E	Material and Equipment	2.85	1st
B	Workforce	2.80	2nd
C	Finance	2.79	3rd
A	Management and control	2.78	4th
D	Project	2.74	5th
F	External	2.67	6th

Table 8 shows the mean of each category of labour productivity factors as they impact on construction project time which indicates that material and equipment group is the most influential with mean of 2.85. This is closely followed by workforce, finance, management and control, project and external groups with little variation in the mean values for all the categories. The slight variation may be as a result of the agreement of researchers that all labour productivity factors have impact on project time (Mahamid *et al.,* 2013). The external group factor ranking least amongst other factor categories supports previous research findings that external factors such as temporary work stoppage due to adverse weather and obtaining building permits and approval are the least important factors for time overrun (Elinwa and Joshua, 2001; Ameh and Osegbo, 2011). Surprisingly, material and equipment being the most influential group is in disagreement with previous findings (Frimpong *et al.*, 2003; Alaghbari *et al.*, 2007; Sweis *et al.*, 2008; Abd El-Razek *et al.*, 2008; Fugar and Agyakwah-Baah, 2010; Ameh and Osegbo, 2011) who all agree that finance is the most influential factor leading to time overrun. The disagreement could mean that there has been a steady improvement in the financing methods for construction projects over the past decade and also improvements recorded in the level of rework due to the advent of collaboration tools like Building Information Modelling (BIM).

Conclusion

The study critically examines labour productivity factors, and determine their impact on construction project cost, and time by eliciting knowledge from project managers who have gained requisite knowledge from experience of handling construction projects. The study concludes that material shortage at project site is a productivity factor that has significant impact on project cost, and can increase the overall project cost if not properly managed. Also, lack of tools and equipment in the market, and workforce absenteeism are productivity factors that had significant impact on construction project time that can lead to delay in project completion. External group are the least impacting labour productivity factors on construction project cost, and time as such, resources should be channelled towards addressing factors in the finance, and material and equipment groups so as to minimize the impact of these labour productivity factors on construction project cost, and time. Enforcing the use of material supply schedule by contractors/suppliers and market survey prior to commencement of project could help control the project cost, and thereby eliminate budget overrun. Conducting survey on availability of tools and equipment before the start of a project, and financial incentives to stimulate employees' commitment could help minimize the significant impact of labour productivity factors on construction project time. Further studies could develop strategies for overcoming material shortage, lack of tools and equipment and workforce absenteeism during construction project execution. Furthermore, the study showed that there could be a likely relationship that exists between labour productivity factors impact on cost, and time and therefore should be explored.

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