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BENEFICIARIES' KNOWLEDGE OF TOOLS IN ACHIEVING PRODUCTIVITY OF LABOUR-INTENSIVE WORK IN GHANA

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ABSTRACT

Purpose: Equipment currently comprises 50-60 % of construction project costs. The lack of proper equipment is the number one cause of construction delays. This article aims to examine the equipment and tools control factors affecting construction labour productivity in Ghanaian construction firms.

Design/Methodology/ Approach: The study adopted a quantitative research design that used questionnaire - base descriptive survey to report on the factors influencing the labour productivity of labour-intensive works The purposive sampling technique was used to select 40 districts as they were on the road construction projects. 560 respondents were considered for the study. The summary of the data consisted of means, standard deviations, and percentages, cross-tabulations, frequencies, figures and charts. Also, factor analysis was used.

Findings: The findings established that the principal axis factoring revealed the presence of three(3) components with eigenvalues above 1. The components Appropriate tools; Beneficiaries' knowledge of tools; and Recording of tools. Construction managers are to monitor workforce performance by asking their suggestions regarding productivity improvement this will go a long way in achieving high productivity.

Research Limitation/Implication: The study focuses equipment framework for estimating the optimal construction labour productivity for labour-intensive works.

Practical Implications: The knowledge of the influence of the three-factor construct which is Appropriate tools; Beneficiaries' knowledge of tools; and Recording of tools could help stakeholders in the construction industry in strategic management of firms and capacity development of labour-intensive works on road construction firms in Ghana.

Social Implications: The knowledge espoused by this study will help the Ghana Social Opportunity project which supervises the implementation of labour-intensive public works on behalf of the Ministry of Employment and Labour in Ghana, in providing relevant training programmes that aim at developing the capacity of indigenous firms to enhance their productivity.

Originality/ Value: The novelty of this study also lies in the labour productivity framework for labour-intensive works on road construction with the focus on the skilful use of equipment that determines labour productivity in the Ghanaian construction industry.

Keywords: *Beneficiaries. knowledge. labour-intensive work. productivity.tools*

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INTRODUCTION

Equipment currently comprises 50-60 % of construction project costs (Bamfo-Agyei, Thwala, & Aigbavboa, 2020). Doloi, Sawhney, Iyer, & Rentala, (2012) argued that the lack of proper equipment is the number one cause of construction delays. Good equipment management begins at the time the equipment is purchased. Purchasing the proper equipment that matches the need of the job while achieving the lowest costs is necessary to attain suitable equipment management (Schaufelberger, & Migliaccio, 2019). Proper record-keeping provides information for planning maintenance and replacement activities, ensuring that they occur at the proper time. Alaghbari, Al-Sakkaf, & Sultan, (2019) revealed that labour input has to be enhanced through the adoption of technologies that are invaluable and appropriate to the local resources and skills in the construction industry.

Nojedehi, & Nasirzadeh (2017) argued that labour is considered to be the most uncertain factor among costly project components (materials, equipment, and labour). The other components, materials, and equipment, are predominantly determined by market prices and are consequently beyond the influence of project management.

Unfortunately, the lack of reliable means for evaluating the efficiency of labour-intensive construction operations seems to make it more difficult for the construction industry to improve productivity and ensure the more effective development of the vital infrastructure that society demands. Construction projects are generally unique and are built on sites with different work crews associated with different trades, levels of education, and weather changes.

There has been limited research on frameworks reflecting the relationship between equipment and construction labour productivity in labour-intensive works in Ghana. However, these limited frameworks even failed to demonstrate accurately the productivity performance using labour-intensive techniques.

This paper aims to develop an equipment framework for estimating the optimal construction labour productivity for labour-intensive works. This framework is context-specific as it relates to the Ghanaian construction industry. The objectives are to determine factors influencing labour productivity in the Ghanaian construction industry; to categorise the measuring tools for determining construction labour productivity in the Ghanaian construction industry, and to develop a holistic construction labour productivity framework using equipment in labour-intensive works.

LITERATURE REVIEW

This section reviews literature about the theoretical and conceptual perspectives on labour productivity in the construction industry. It also examines some of the historical developments leading to a definition of the term 'productivity, develops the concept of productivity into the various definitions, and discusses the accepted definitions in general and in construction. Major labour productivity theories on labour-intensive in early times and in recent times are reviewed.

Evaluation of labour productivity frameworks developed is discussed to identify a suitable framework.

Productivity Definitions

Productivity, according to Jarkas & Bitar (2012), is the relationship between production and the means used to achieve it. Productivity is defined in the context of performance measurement–i.e., as a measure of how successfully resources are utilized to achieve set targets or desired outputs–in a more industry-relevant definition that is commonly recognized among construction industry players (Durdyev & Mbachu 2018).

Meanwhile, labour productivity was defined by Kavithra, Ambika, Shreena, & Shankari (2017) as the number of goods and services generated by a productive factor per unit of time or cost. The volume of work-hours used and production is the operational definitions of labour productivity that are relevant for this research investigation. It's also the relationship between the number of input factors used by a system to generate output and the output generated by the system.

Historical perspective of labour-intensive public works in Ghana

Historical evidence suggests that labour-intensive techniques were used in Ghana during the pre- and post-independence era, especially in the provision of some public goods and services. The technique's use in Ghana may be traced back to Governor Guggisberg's ten-year development plan for the Gold Coast (1919). Infrastructure development was heavily reliant on labour-intensive methods under the plan. The technique was employed extensively in the construction of Takoradi Harbour, the Korle-Bu Teaching Hospital, railway networks, and several official government mansions and offices, for example (GSOP, 2017).

During the period 1958-1965, Dr. Kwame Nkrumah's seven-year growth plan, which aimed to accelerate economic expansion to absorb unemployed people, used labour-intensive ways to produce a significant number of public sector positions. The Ghana Workers Brigade was developed as a work and training program as a short to medium-term development plan to address the concerns of unemployment and build national physical assets. The Workers Brigade strategy was a successful mass employment intervention that produced jobs and provided the country's labour force with the necessary technical and vocational skills. Construction of fifteen-unit classroom blocks and dormitories for all secondary schools in Ghana, low-cost housing projects, and the creation of public estate housing plans in key towns all utilised the labour-intensive technique (GSOP, 2017).

The government initiated a mass (civic) education campaign and organized men and women in their communities for different rural development initiatives during the Second Republic (1969-1972). The Operation Feed Yourself and the National Reconstruction Programme under the National Liberation Council (NLC) leadership (1972) involved the widespread mobilization of the populace for greater agricultural production to secure food security and better public infrastructure.

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The Government implemented the National Mobilization Program as a labour-intensive public works initiative under the Provisional National Defense Council (PNDC: 1983-1985). Around one million Ghanaian returnees from Nigeria (1983) were mobilized under this program for agricultural and infrastructure development projects. In 1986, labour-intensive procedures were utilized to restore 3,989 kilometres of gravel roads and produce nearly 7 million person-days of employment as part of the Fourth Highway Pilot Project. The Department of Roads and Highways' Mobile Upkeep Unit also used (and continues to use) labour-intensive public works techniques in the maintenance of selected feeder roads in the country.

The Ghanaian government released a National Social Protection Strategy (NSPS) in 2007/2008, which identified social protection (safety net) program deficiencies in the sector. The approach required the government to implement two (2) essential social protection interventions, namely a "cash transfer program" and a "public works program," which were both absent from the social protection scene at the time. Under the then-Ministry of Employment and Social Welfare, the government began implementing a trial Cash Transfer program called Livelihood Empowerment Against Poverty (LEAP) in 2008.

The Ghana Social Opportunities Project (GSOP) was launched in October 2010 with the support of a World Bank facility to further the objectives of the National Social Protection Strategy (NSPS) by strengthening the implementation of the two key social protection interventions, as identified above, by supporting the full roll-out of the ongoing LEAP and the introduction of a public works intervention, namely the Labour-Intensive Public Works (LIPW). Although the initiative began in October 2010, it was not until October 2011 when LIPW activities were implemented. In 60 districts in five zones, the Labour-Intensive Public Works programme is in operation. The Labour-Intensive Public Works (LIPW) has rehabilitated 1336.48km feeder roads, 293 small earth dams and dugouts projects and 373 projects under climate change (GSOP, 2017).

The Ghana Social Opportunities Project, Labour-Intensive Public Works' pilot programme has produced excellent outcomes. The labour-intensive road development activities have benefited 634 communities in 60 district assemblies after ten years of implementation. 167,245 people were employed for a total of 7,879,360 man-hours, with women accounting for 61% of the workforce. Climate change mitigation, minor earth dams, and feeder roads were among the sites where the intervention was made (GSOP, 2017). Beneficiary district assemblies are chosen based on poverty and deprivation levels, as well as regional balance. The Savannah region accounts for around 71.7% of the beneficiary district assemblies (GSOP, 2017).

Early Theories of Labour Productivity with Equipment

Smith (1776) used the example of a pin factory to demonstrate how specialisation may considerably increase human output. To increase productivity, he said, labour-saving machinery is used. Smith (1776) stated that the employment of machines simplifies individual job tasks, reducing working hours and allowing a few individuals to do the work of many others.

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The equipment component, according to Smith's theory, is the most important contributor to a firm's labour productivity. This crucial aspect in Smith's labour productivity theory might be seen as a foundational approach to the first economic rationalization.

Any interference and/or interruption in the usage of the equipment causes major material handling issues, as well as a labour slowdown or a complete cessation of operations. As a result, equipment availability is seen as important to the progress of road maintenance. According to Attar et al., (2012), building site productivity was limited by regular equipment breakage and a lack of tools. Equipment affects construction labour productivity, (Goodrum & Haas, 2002).

The relationship between improvements in equipment technology and partial factor productivity was studied by Goodrum & Haas (2002). Goodrum & Haas (2002) looked at the relative influence of five major types of equipment technology: energy, control, functional range, information processing, and ergonomics.

Labour Productivity Conceptual Frameworks

This paper aimed to build a conceptual labour productivity framework for labour-intensive works with a focus on road construction that will aid the Ghanaian construction industry. The theoretical conceptual framework for the current paper builds on the work of Thomas & Sakarcan (1994); Sheikh, Lakshmipath & Prakash (2016) and Cheng, Rashidi, Davenport & Anderson (2017) their frameworks of labour productivity are discussed in this section.

The equipment and tools component was highlighted as one of the components that influence productivity in Thomas & Sakarcan's (1994) theory of labour productivity. Increased output, lower overall costs, carrying out activities that cannot be carried out manually, maintaining the planned rate of production when there is a labour shortage, and maintaining a high-quality standard are just a few of the benefits of equipment utilization. As a result, proper equipment selection and utilization contribute to the project's economics, quality, safety, speed, and timely completion.

Improper equipment selection, unavailability of equipment at the appropriate time, increased cycle time and waiting time, as well as bad technology and incorrect mechanization, can all cause delays in project execution. Sheikh, Lakshmipath, & Prakash (2016) discovered that these issues can be solved by using queuing theory to pick equipment that minimizes delays by reducing cycle time and idle time and thereby lowering costs.

According to Sheikh et al. (2016), queuing theory necessitates the examination of characteristics that govern equipment design and selection to establish equipment requirements (type and optimum number), waiting time, idle time, cycle time, and time spent in the system. According to Cheng, Rashidi, Davenport, & Anderson (2017), the operator must manually classify and record productive vs nonproductive (or idle) periods throughout the process. The results are manually put into timesheets or other sorts of records, together with other important information such as maintenance notes and the quality of the completed job.

The final goal of this method is to calculate the proportion of equipment time spent on value-adding tasks and, as a result, to assess the machine's productivity rates, which will be utilized for time and cost analysis in the future.

Sheikh, et al., (2016) identified the factors affecting equipment selection as including site considerations, economic considerations, equipment specifications, labour consideration, client and project specifications, among others.

This current conceptual framework for this study looks at the relationship between the factors of equipment and tools and labour intensive works, which are the essential variables that the majority of previous studies have measured. It is based on the fundamental factors and constructs associated with all previous frameworks. However, this study took into account the impact of beneficiaries' tool knowledge on labour productivity in the construction industry. This is an exogenous variable that has a role in determining overall labour productivity in labour-intensive jobs. As a result, local construction labour productivity will be predicted.

Despite these diverse research efforts, existing frameworks have challenges such as the inability to allow a subjective evaluation of these parameters and the reliance on and requirement for large data sets for model creation and testing. Some of these issues are attempted to be addressed by the framework.

RESEARCH METHODOLOGY

Research Design

To report on the factors impacting the labour productivity of labour-intensive works, the study used a quantitative research approach that used a questionnaire-based descriptive survey. It also provides information on the firms' productivity levels. The descriptive survey aims to provide an accurate and objective portrayal of a current scenario or real-life situation (Fellows & Liu, 2008). This strategy is ideal because it allows researchers to extrapolate results from a specific group (Creswell, 2014; Bryman, 2012). The variables that management should utilize to measure labour productivity were set at fifteen in the questionnaire. Principal Component Analysis (PCA) was used to analyze factors and reduce measured variables to smaller factors that are important for labour productivity. PCA can be used to extract factors, to summarize the data into a reasonable number of factors based on the greatest Eigenvalues (Rossoni, Engelbert, & Bellegard, 2016).

Population, sampling and response rate

All contractors, site engineers, facilitators, timekeepers, Director of Public Works, and Ghana Social Opportunity Project (GSOP) desk officers participating in labour-intensive works on road construction in Ghana are part of the study's target group. According to records from the Ghana

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Social Opportunity Project (GSOP), 920 professionals are working in labour-intensive jobs in Ghana, according to demographic research.

Bolgatanga, Wa, Temale, Kumasi, and Accra are the five zonal offices that GSOP operate. The stratified sample technique was adopted because the country was divided into zones, and the population was different. Bolgatanga has 12 district offices, Wa has 10 district offices, Temale has 11 district offices, Kumasi has 14 district offices, and Accra has 13 district offices for all the zonal offices.

The purposive sample technique was utilized to choose 40 districts that were involved in road construction projects because not all district offices handled road construction projects. One Director of Public Works and one GSOP desk officer were chosen from each of the 40 districts, totalling 80 responders. Again, three (3) sites were chosen from each district, for a total of 120 districts. One facilitator, one-time keeper, one site engineer, and one contractor were chosen from each of the 120 sites, for a total of 480 responders. A total of 560 people were considered for the research. Out of 560 respondents, 543 completed the questionnaire completely, yielding a response rate of 97%. A sample size of 175 is recommended by Krejcie & Morgan (1970) for a population of 950. This recommendation confirms that a sample size of 560 is adequate for a population of 920 people.

Data collection

From November 2016 to August 2017, 560 questionnaires were delivered to prospective respondents who work on labour-intensive works on road projects in Ghana using drop-and-collect and email methods. Some of the items on labour productivity in the questionnaire were culled from literature reviews, while others were created by the researcher, resulting in the creation of a two-sectioned questionnaire.

The first portion gathered demographic information about the respondents, such as their age, gender, occupation, educational background, level of experience, and geographic region.

The concept 'factors crucial for equipment and tool control' was given 15 Likert-scale questions in the second segment. Respondents were asked to rate how important these factors are in influencing the productivity of labour-intensive works in Ghanaian construction firms. The results from these measurements were utilized to create Likert-scale items for the descriptive analysis as well as variables for the inferential statistics, which were used to test the factors' validity and reliability. To reduce the respondents' bias, closed-ended questions were preferred for section two (Harlacher, 2016).

Method of analysis and interpretation of the data

The data were analysed using the Statistical Products and Service Solutions (SPSS) version 24.0 program and presented in tables and diagrams (Pallant, 2013). Using descriptive statistics, the

ISSN: 2408-7920

frequencies and percentages were generated and reported to analyse the respondents' background characteristics.

The ranking of the mean scores of the equipment and tools control factors (measuring tools) was done using a five-point Likert scale to rate the quality of the initial 15 items for measuring labour productivity in labour-intensive works. Likert-type or rating scales use fixed choice response formats and are designed to measure opinions (Singh, 2006). The following scale measurement was used regarding mean scores, where 1 = Very poor (≥1.00 and ≤1.80); 2 = Poor (≥1.81 and ≤2.60); 3 = Average (≥2.61 and ≤3.40); 4 = Good (≥3.41 and ≤4.20), and 5 = Excellent (≥4.21 and ≤5.00).

Cronbach's Alpha values were conducted in line with (Wahab, Ayodele & Moody, 2010) to determine the internal reliability of the 13 items. Acceptable Cronbach's alpha range from 0.70 to 0.95 (Tavakol & Dennick, 2011), thus a cut-off value of 0.70 was adopted for this study.

For factor loadings to be reliable, Pallant, (2013) suggest a range from 0.2 to 0.4 as the optimal inter-item correlations mean (factor loading) therefore, this study adopted a value of 0.4 and above.

To determine the adequacy of the data for factor analysis, the Meyer-Olkin (KMO) (Lorenzo-Seva, Timmerman, & Kiers, 2011) and Bartlett's Test of Sphericity (Hair, Black, Babin, & Andersen, 2014) tests were used. Because the KMO test scores range from 0 to 1, values above 0.7 are required for utilizing Exploratory Factor Analysis (EFA) in this study (Hair, et al., 2014). A statistically significant Bartlett test ($p<0.05$) shows that the variables are sufficiently correlated to proceed with the study (Pallant 2013).

Oblimin with Kaiser normalization and Principal Component Analysis was used to decrease the initial factors to a minimum number of factors, concentrating the explanatory power on the first factor, for factor extraction and rotation (Rossoni, et al., 2016).

4. FINDINGS

This section provides demographic information on individual respondents. The analyzed results for the descriptive data were the respondents' background information including their individual information and the company information. Descriptive statistics such as percentages, means and standard deviation were used in the analysis.

4.1 Demographic profile of the respondents and firms

Table 1 presents the profile of the 543 respondents. Based on the frequency of occurrence, most of the respondents (87%) were males, aged between 26 and 35 years (51.1%). The majority of the respondents (27.8%) were engineers and others were equally employed as contractors, timekeepers and facilitators (22.1% each). Most of the respondents (66.9%) had either a bachelor's degree (36.3) or technical qualification (30.6%), and 16.9% had matriculated. Although 47% of the

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respondents have between two and five years' work experience, a slight majority (53.1%) have six years' work experience or more. This proves that the respondents are qualified to work in the construction industry and have adequate experience to give information that could help in making deductions on factors measuring labour productivity. Respondents were almost equally distributed for the geographical locations with 20.6% from Bolgatanga, 20.6% from Wa, 20.3% from Tamale, 20.1% from Kumasi, and 18.4% from Accra, but a greater percentage (61.5%) of the respondents work in the three northern regions of Ghana namely Bolgatanga, Wa and Tamale.

Table 1: Respondents' profile

Demographic	*Characteristic*	*Frequency*	*Percentage*
Gender	Male	472	87
	Female	71	13
Age	<20 years	26	4.8
	20-25years	52	9.6
	26-30 years	148	27.3
	31-35 years	129	23.8
	36-40 years	106	19.5
	41-45 years	73	13.4
	46 years or above	9	1.7
Occupation	Contractors	120	22.1
	Site engineers	119	21.9
	Timekeepers	120	22.1
	Facilitators	120	22.1
	GSOP desk officers	32	5.9
	Director of Public Works	32	5.9
Education level	Masters degree	16	2.9
	Bachelor's degree	197	36.3
	National diploma	72	13.3
	Technical/SSCE	166	30.6
	Matric certificate/BECE	92	16.9
Experience	2-5 years	255	47
	6-10 years	202	37.2
	11-15 years	51	9.4
	16-20 years	22	4.1
	20 years and above	13	2.4
Geographical location	Bolgatanga	112	20.6
	Wa	112	20.6
	Tamale	110	20.3
	Kumasi	109	20.1
	Accra	100	18.4

Descriptive analysis

Table 2 shows the Mean Score (MS) and Cronbach's *alpha* values of the 15 identified equipment and tools control factors that influence labour productivity of the firms in labour-intensive works on road construction in Ghana in descending order, as rated by the respondents.

ISSN: 2408-7920

Table 2: Ranking of Equipment and Tools Control Factors

Factors *(N=543)* 1 = very poor … 5 = excellent	MS	Cronbach's *alpha*	Rank
Use of equipment for a suitable time	4.26	0.868	1
Advanced planning to manage the use of equipment	4.09	0.885	2
Appropriateness of tools to be used for the tasks	4.08	0.850	3
Keeping the same crew and operator on the same piece of equipment	4.06	0.872	4
Availability of tools	4.02	0.905	5
Operators are assigned to specific tools	3.88	0.751	6
Maintenance of tools	3.74	0.934	7
Frequency of reports provided by tool room supervisors	3.72	0.736	8
Keeping a record of all tool kit assignments, as well as tools not included in the kits	3.66	0.720	9
Frequency of equipment usage reports	3.64	0.778	10
Issuing of tool kits based on trade	3.54	0.793	11
Storage of non-permanently used tools in storerooms	3.50	0.876	12
Quality of scheduling of equipment use	3.48	0.874	13
Frequency of site inventories to control loss, theft, and breakage	3.43	0.701	14
The degree to which each person is held accountable for a tool kit	3.28	0.777	15

The top five variables that recorded rating scores above 4.0 included Use of equipment for a suitable time (MS=4.26); Advanced planning to manage the use of equipment (MS=4.09); Appropriateness of tools to be used for the tasks (MS=4.08); Keeping the same crew and operator on the same piece of equipment (MS=4.06) and Availability of tools and perceived by respondents as excellent factors when measuring labour productivity in labour-intensive works.

Operators are assigned to specific tools (MS=3.88); Maintenance of tools (MS=3.74); Frequency of reports provided by tool room supervisors (MS=3.72); Keeping of a record of all tool kit assignments, as well as tools not included in the kits (MS=3.66); Frequency of equipment usage reports (MS=3.64) were rated by respondents as 'good' in their firms. Other equipment and tools control factors that were rated by respondents as 'good' were Issuing of tool kits based on trade (MS=3.54) and the Storage of non-permanently used tools in storerooms (MS=3.50). Quality of scheduling of equipment use (MS=3.48); Frequency of site inventories to control loss, theft, and breakage (MS=3.43) and the degree to which each person is held accountable for a tool kit (MS=3.28) were rated as 'average' and ranked the lowest of all the items. The Cronbach's *alpha* values for each factor was greater than 0.70, indicating acceptable internal reliability, as recommended by Hair, *et al*. (2014).

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Inferential statistics

Principal Component Analysis

The 15 equipment and tools control factors that can promote labour productivity of labour-intensive works on road construction were subjected to PCA to assess their validity and reliability. The results report the suitability of the data to be analysed, factor extraction and rotation, and interpretation.

As shown in Table 3, the KMO measure of sampling adequacy achieved a value of 0.920, exceeding the recommended minimum value of 0.7 and Bartlett's test of sphericity was also statistically significant (<0.05), thus supporting the factorability of the data.

Table 3: KMO and Bartlett's test of Equipment and Tools Control

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.920
Bartlett's Test of Sphericity	Approx. Chi-Square	9192.335
	df	105
	Sig.	.000

The pattern matrix in Table 4 shows that out of the initial 15 variables, PCA extracted 15 variables in three components with factor loadings above 0.4 with the potential to influence labour productivity of labour-intensive works on road construction in Ghana.

Table 4: Pattern Matrix of Equipment and Tools Control Variables (ETC)

	Component		
	1	2	3
ETC6 Frequency of site inventories to control loss, theft, and breakage	**0.909**	-0.188	-0.04
ETC8 Appropriateness of tools to be used for the tasks	**0.869**	0.298	-0.109
ETC9 Maintenance of tools	**0.847**	0.092	0.098
ETC7 Availability of tools	**0.830**	-0.18	0.095
ETC12 Advanced planning to manage the use of equipment	**0.655**	0.287	-0.088
ETC11 Use of equipment for a suitable time	**0.640**	0.281	0.149
ETC13 Keeping the same crew and operator on the same piece of equipment	0.118	**0.797**	0.012
ETC10 How well operators are assigned to specific tools	0.312	**0.609**	0.246
ETC1 Storage of non-permanently used tools in tool rooms	-0.192	0.221	**0.809**
ETC2 Frequency of reports provided by tool room supervisors	0.220	0.340	**0.768**
ETC5 Keeping of a record of all tool kit assignments, as well as tools not included in the kits	0.363	0.206	**0.706**
ETC3 Issuing of tool kits based on trade	-0.305	0.17	**1.000**
ETC14 Frequency of equipment usage reports	0.123	-0.05	**0.947**

African Journal of Applied Research
Vol. 7, No. 2 (2021), pp. 176-193
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ETC4 Degree to which each person is held accountable for a tool kit	0.388	-0.315	**0.594**
ETC15 Quality of scheduling of equipment use	0.310	-0.237	**0.569**
Extraction Method: Principal component analysis.			
Rotation Method: Oblimin with Kaiser normalization.a			
a Rotation converged in 17 iterations.			

Table 5 shows that after rotation, three components with eigenvalues exceeding 1.0 were extracted and are meaningful to retain. Factor one explains 50.56% of the total variance; factor two, 17.97% and factor three, 10.00%. Thus, the final statistics of the PCA shows that three extracted factors explain a cumulative variance of approximately 78.5%.

Table 5: Total Variance Explained of Equipment and Tools Control Variables (ETC)

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	7.584	50.559	50.559	7.584	50.559	50.559	6.389
2	2.696	17.974	68.533	2.696	17.974	68.533	2.363
3	1.500	10.002	78.535	1.500	10.002	78.535	5.533
4	0.791	5.272	83.807				
5	0.645	4.302	88.109				
6	0.412	2.743	90.852				
7	0.336	2.238	93.090				
8	0.265	1.767	94.857				
9	0.203	1.353	96.210				
10	0.178	1.190	97.400				
11	0.128	0.854	98.254				
12	0.094	0.630	98.884				
13	0.080	0.531	99.415				
14	0.055	0.369	99.785				
15	0.032	0.215	100.000				
Extraction Method: Principal Component Analysis							
[a.] When components are correlated, sums of squared loadings cannot be added to obtain a total variance							

Table 6 revealed the correlation of variables based on their factor loadings after rotation in PCA. Three components with eigenvalues above 1 as shown in Table 4 were examined on the inherent relationships among the variables under each factor. Variables with the highest factor loading in one component belong to that component; the highest factor loading must be of a significant value of 0.4 and above (see Table 4). Component 1 was labelled **Appropriate tools**; Component 2 **Beneficiaries' knowledge of tools**; and Component 3 **Recording of tools**. The names given to these factors were derived from a close examination of the variables within each of the factors.

African Journal of Applied Research
Vol. 7, No. 2 (2021), pp. 176-193
http://www.ajaronline.com
http://doi.org/10.26437/ajar.10.2021.12

Table 6: Rotated Factor Matrix for Equipment and Tools Control Variables (ETC)

	Component		
	1	2	3
	Appropriate tools	Beneficiaries' knowledge of tools	Recording of tools
ETC6 Frequency of site inventories to control loss, theft, and breakage	0.909		
ETC8 Appropriateness of tools to be used for the tasks	0.869		
ETC9 Maintenance of tools	0.847		
ETC7 Availability of tools	0.830		
ETC12 Advanced planning to manage the use of equipment	0.655		
ETC11 Use of equipment for suitable time	0.640		
ETC13 Keeping the same crew and operator on the same piece of equipment		0.797	
ETC10 Operators are assigned to specific tools		0.609	
ETC1 Storage of non-permanently used tools in tool rooms			0.809
ETC2 Frequency of reports provided by tool room supervisors			0.768
ETC5 Keeping a record of all tool kit assignments, as well as tools not included in the kits			0.706
ETC3 Issuing of tool kits based on trade			1.000
ETC14 Frequency of equipment usage reports			0.947
ETC4 Degree to which each person is held accountable for a tool kit			0.594
ETC15 Quality of scheduling of equipment use			0.569
Extraction Method: Principal component analysis			
Rotation Method: Oblimin with Kaiser normalization[a]			
[a] Rotation converged in 17 iterations			

Component 1: Appropriate tools

This component with six sub-factors accounts for 50.6% of the total variance. As presented in Table 5, a correlation exists between variables 6, 8, 9, 7,12 and 11 as they are loaded onto Component 1. The variables that had high loading are Frequency of site inventories to control loss, theft, and breakage (0.909), Appropriateness of tools to be used for the tasks (0.869), Maintenance of tools (0.847), Availability of tools (0.830), Advanced planning to manage the use of equipment (0.655) and Use of equipment for a suitable time (0.640). Schaufelberger & Migliaccio (2019) further endorsed the results obtained in this paper, who positioned the job of the construction manager as to match the right piece of equipment or combination of equipment to the individual tasks to be performed in completing the project.

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Component 2: Beneficiaries' knowledge of tools

Beneficiaries' knowledge of tools accounts for 17.97% of the total variance and comprises two correlated variables that load onto Component 2. Keeping the same crew and operator on the same piece of equipment (0.797) and Operators are assigned to specific tools (0.609) has factor loadings. The outcome is justified because tools have advanced the understanding and appropriation of the concept of resilience, its operationalization by construction managers so far has been limited.

The related impact of this result is in agreement with the outcomes reported by Heinzlef, Robert, Hémond, & Serre (2020) who argued that general lack of knowledge of tools, a specific technicality of the tools, the inadequacy of the tools in the face of local risk beneficiary knowledge and practices. Nevries, & Payne (2017) recommended that there needs to be proper knowledge of tools by the beneficiaries in achieving productivity of construction works.

Component 3: Recording of tools

This component with seven sub-variables accounts for 10.00% of the total variance. A correlation exists between variables1,2,5 3, 14, 4, and 15 as they are loaded onto Component 3. Storage of non-permanently used tools in tool rooms (0.809), Frequency of reports provided by tool room supervisors (0.768), Keeping of a record of all tool kit assignments, as well as tools not included in the kits (0.706), Issuing of tool kits based on trade (1.000) and Frequency of equipment usage reports (0.947) had high factor loadings. While Degree to which each person is held accountable for a tool kit (0.594) and Quality of scheduling of equipment use (0.567).

DISCUSSION

From the results from the descriptive analysis, it was observed that 15 variables listed of the equipment and tools control factors were identified. The findings indicated that 'Use of equipment for suitable time can influence labour productivity of labour-intensive works on road construction was ranked first with a mean score of 4.26. 'Advanced planning to manage the use of equipment was ranked second with a mean score of 4.09, 'Appropriateness of tools to be used for the tasks' was ranked third with a mean score of 4.08, 'Keeping the same crew and operator on the same piece of equipment was ranked fourth with a mean score of 4.06, and 'Availability of tools' was ranked fifth with a mean score of 4.02.

While 'Operators are assigned to specific tools was ranked sixth with a mean score of 3.88, 'Maintenance of tools' was ranked seventh with a mean score of 3.74, 'Frequency of reports provided by tool room supervisors' was ranked eighth with a mean score of 3.72, 'Keeping a record of all tool kit assignments, as well as tools not included in the kits' was ranked ninth with a mean score of 3.66 and 'Frequency of equipment usage reports' was ranked tenth with a mean score of 3.64. Moreover, 'Issuing of tool kits based on trade' was ranked eleventh with a mean score of 3.54, 'Storage of non-permanently used tools in tool rooms' was ranked twelfth with a mean score of 3.50, 'Quality of scheduling of equipment use' was ranked thirteenth with a mean score of 3.48,

ISSN: 2408-7920

'Frequency of site inventories to control loss, theft, and breakage' was ranked fourteenth with a mean score of 3.43, and 'Degree to which each person is held accountable for tool kit' was ranked fifteenth with a mean score of 3.28.

The results from the PCA analysis identified three main factors that can influence the equipment and tools component in promoting labour productivity of labour-intensive works on road construction. These included appropriate tools, beneficiaries' knowledge of tools and recording of tools that influenced labour productivity.

The following attributes are correlated with the latent variable: lack of tools and equipment; adequacy of the equipment and tools used. This result is justified by the assertion of Attar et al. (2012) that labour needs a minimum amount of equipment and tools in the specially designed programme of the Ghana Social Opportunity project on labour-intensive works on road construction. The findings are in agreement with Abdalgbar (2017) who argued that labour-intensive works require hand tools such as shovels, holes, cutlasses, mattocks, wheelbarrows, picks and deadweight rollers which can be used.

CONCLUSION AND RECOMMENDATION

The empirical findings from this paper are consistent with the theoretical review. This is noted from the empirical findings which revealed that the three components of equipment and tools which are Appropriate tools; Beneficiaries' knowledge of tools; and Recording of tools influenced labour productivity. Construction equipment and tools are the backbones of road construction using labour-intensive works.

The novelty of this study also lies in the labour productivity framework for labour-intensive works on road construction, it informs as to the components including Appropriate tools; Beneficiaries' knowledge of tools; and Recording of tools that determine labour productivity of labour-intensive works on road construction in the Ghanaian construction industry. Similarly, the latent variables which led to the labour productivity outcome variables could be used for firms' labour productivity measurement in the Ghanaian construction industry.

Practical contribution and value

Road contractors, especially in Ghana, have not realised the significance of Beneficiaries' knowledge of tools to the labour productivity of their construction sites. However, the PCA results have indicated that the Beneficiaries' knowledge of tools component significantly influences firms' labour productivity in the construction industry, especially in Ghana.

Knowledge of the influence of Beneficiaries' knowledge of tools on the productivity of labour-intensive works on road construction could be acquired by construction professionals who are desirous of their firms having a competitive edge in terms of being productive in the construction industry. In particular, the influence of the following factors is significant when it comes to labour productivity of labour-intensive works on road construction in the Ghanaian construction industry, namely**,** Advanced planning to manage the use of equipment; Appropriateness of tools to be used for the tasks; Keeping the same crew and operator on the same piece of equipment; Availability of tools; Operators are assigned to specific tools; Maintenance of tools; Frequency of reports provided by tool room supervisors; Keeping a record of all tool kit assignments, as well as tools not included in the kits; Frequency of equipment usage reports; Issuing of tool kits based on trade; Storage of non-permanently used tools in tool rooms; Quality of scheduling of equipment use; Frequency of site inventories to control loss, theft, and breakage; and Degree to which each person is held accountable for tool kit.

Moreover, construction professionals could use this knowledge to help with decision making in the firm. This research study can also be introduced as an important tool in planning to fast-track the effective utilisation of road construction work using the labour-intensive approach to improve productivity by completing the work as scheduled in the contract. It can also assist the contractors to forecast the time it will take to construct a given road using the labour-intensive method.

Moreover, the knowledge of the influence of the three-factor construct could help stakeholders in the construction industry in curriculum design and delivery, policy formulation, strategic management of firms, and capacity development of labour-intensive works on road construction firms in Ghana matters relating to construction labour productivity.

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