Towards a Framework for Enhancing Construction Project Labour Productivity in Kenya

Senteu ole Murianka[1], Mugwima Njuguna[2] and Njeri Wachira-Towey[3]

[1]School of Engineering & Technology, Kirinyaga University, P.O. Box 143 - 10300, Kerugoya, Kenya.

[2]School of Architecture & Building Sciences, Jomo Kenyatta University of Agriculture and Technology, P.O. Box 62000 - 00200, Nairobi, Kenya.

[3]School of Built Environment, University of Nairobi, P.O. Box 30197 – 00100, Nairobi, Kenya.

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ABSTRACT

Based on labor productivity, construction projects in Kenyan cities and beyond will either succeed or fail. Absence or insufficiency of labor productivity management makes it difficult or impossible for clients and contractors to accurately estimate project costs, which causes costs to rise, profits to decline, project execution times to lengthen, projects to stall, and industry confidence to decline. The topic of construction labor productivity is investigated in this exploratory study among Nairobi-based practitioners and on Nairobi-based projects. It defines the word and assesses the body of literature that is currently available. Next, it assesses several facets of labor productivity in building projects and among practitioners. Lastly, it clarifies significant aspects of CLP in the sector.

Key Words-Labour, Productivity, Construction, Projects, Management.

INTRODUCTION

The key to enabling the construction industry's extraordinary expansion may lie in the management and enhancement of Construction Project Labour Productivity (CPLP). In a ground-breaking economics research revealing the factors enabling certain countries and geographical regions to be more prosperous than others, Paul Krugman the Nobel laureate concluded that, "*Productivity* [Labour] *isn't everything, but in the long run it is almost everything"* [11]. This is especially true for the building sector, which continues to be labor-intensive with labor accounting for 50–65% of construction project costs [8], [18].

Regardless of size, productivity is one of the key elements determining an organization's total performance, and labor performance issues are typically linked to profitability [1].

In the context of the Kenyan construction industry, there are no structured methods of measuring, managing or improving Labour Productivity. Further, there are no nationally accepted standards and/or metrics. Construction labour Productivity (CLP) measurements and rates are currently calculated based on a practitioner's experience or individual site surveys. According to the Kenyan State Department of Labour, the situation is so dire that the government admits that Kenya does not have a robust framework for measuring productivity. Further, the nation seeks to establish productivity improvement cultures and values in the nation by increasing the current productivity awareness of 1% to 60% by 2030 and attaining an annual productivity growth of 5% from the prevailing annual productivity growth rate of less than 1% [5], [15].

LITERATURE

A. Study Area

The study was undertaken on building projects in Nairobi City County (NCC), Kenya. NCC receives the highest financial allocation compared to all the other counties with the second receiving nearly half [10]. In spite of this,

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NCC continues to struggle with a limited technical capability, a low resource base, and infrastructure that were not designed for the massive population that now calls the city home [16]. The last challenge is as a result of the high population growth rates due to the rapid urbanization the city has experienced since independence. Nairobi's population is projected to be over 5.0 million, making up approximately 35% of Kenya's urban population and 9% of the nation's total population, but occupying just 0.1% of the country's surface area. Thus the population density of the city overall is over 7,183 people per square kilometre [10].

Because of the high population in Nairobi land use patterns & settlement, solid waste generation rate as well as facilities like housing, roads infrastructure, water supply system, drainage system, health and education have been affected. This current population has put pressure for higher volumes of construction not only in housing for the large population but also construction of transport infrastructure to ease movement within, to and from the city. In the financial year 2022/2023, Nairobi had an average of over 1,500 new housing projects receiving construction approval [10], [22], [23].

The study evaluates the level of CLP awareness and knowledge among practicing construction professionals, quantifies CLP measurement on projects and rates the factors considered important in CLP. Based on this information, the study offers recommendations on the way forward in managing of the issue within the industry.

B. Productivity

The meaning of productivity is lost to many persons involved in production [8]. The term is commonly used but often poorly defined in both academic and practical discussions. Productivity has always been confused with performance. Nonetheless, the productivity measure is correctly recognized by the Industrial Key Performance Indicators (KPIs) as a subset of the larger company performance measure [20].

The productivity measure is used principally to compare the economic performance of one country with that of another but can also be used as an efficiency indicator especially in measurement of industry performance. Productivity is therefore considered to be a component of growth. Although most people in charge of production assign productivity a secondary status, it is, in fact, the most significant factor influencing economic production activities [19], [20].

To put it simply, productivity is the amount of output produced from a given set of inputs, or production efficiency. Productivity measures a nation's or organization's capacity to produce more value-added or income. It's a ratio that illustrates how well a business or organization converts a given set of resources into goods or services [17]. In industrial engineering, productivity is generally defined as the volume measure of output divided by the volume measure of input consumed [13]. Productivity can be defined by Equation 1 [7], [19].

$$P = \frac{O}{I} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where:-

P – Productivity

O – Outputs

I - Inputs

Total Factor Productivity and Partial Productivity are the two categories of productivity [10], [13]. Labor, capital, material, and energy are just a few examples of the inputs and outputs that make up a manufacturing process' transformation system. The process of linking each different input to the outcome is known as total factor productivity, or TFP. Partial Productivity (PP) involves relating the output with some but not all input. The use of one factor of input to evaluate productivity is called Single Factor Productivity (SFP) while the use of more than one factor but less than the total number of factors is called Multifactor Productivity (MFP). The most common and widely used Partial Productivity measure (also a Single Factor Productivity measure) is that of Labour Productivity (LP) which measures only the contribution of the labour factor. At the company level, labor

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productivity is simply defined as total created output or sales per employee [1].

C. Labour Productivity in Construction

The ratio of output to input, or the quantities produced per employee hour of effort, is referred to as labor productivity in the construction industry. Labour Productivity is a Single Factor Productivity Measure because it considers the effect of only a single input. To put it simply, labor productivity is the rate of output per unit of time or effort, commonly expressed in labor-hours. For example, the amount of concrete placed, conduits installed and pipe inserted per crew hour is measured in per labour-hour [19].

As per these definitions, Labour Productivity may therefore be expressed mathematically as:-

$$Labour\ Productivity\ (LP) = \frac{Output}{Labour\ Cost}\ or\ \frac{Output}{Work\ Hour} \ldots (2)$$

Where:

1. Output is the delivered construction product measure either in monetary terms if several components form the overall output or units of the product if a single output eg m^3 in concrete or m^2 of floor area.
2. Labour cost is the cost of delivering the output measured in monetary terms or man-hours or man-days.
3. Man-hour is the labour utilized in one hour by one person working on the output.
4. Man-day is the labour utilized in one day by one person working on the output.

CLP management is critical across the entire continuum of construction production. Depending on the needs, CLP can be monitored at many levels, including trade, task or activity level, project level, business level, and industry level [4]. Each level of measurement serves specific objectives pertinent for that level.

This study is based on project level CLP measurement. Construction project level labour productivity measurement is considered necessary for facilitating improvements at the project level and ensuring the accounting of the entire construction process as compared to measuring individual components of the construction or crafts (e.g. concrete, masonry, structural elements, etc.) which lends itself to reductionism. Furthermore, because the construction sector is mostly project-based, assessing productivity at the project level is essential. Projects are the group of tasks needed to build a new facility (such as a power plant, bridge, or commercial office building) or to renovate an existing facility (such as by adding to, changing, or replacing major components) [3], [4], [12], [13], [17].

Project Level CLP may be measured in Gross Floor Area per Man-Day with output being Gross Floor Area of the project and input being the labour measured in man-days. The GFA per man-day is currently utilized as a formal CLP measure by Singapore, Malaysia, China, Hong Kong, Japan and Finland [21].

MATERIALS AND METHODS

This exploratory study is a component of a larger investigation aimed at creating a framework for raising Kenyan construction labor productivity at the project level. The data collection methods used were questionnaires and field notes. Questionnaires were administered on construction project personnel to collect data concerning project CLP. The respondents were construction practitioners, construction managers and project supervisors. Additionally, observation was used to collect data on project level CLP. A total of fifteen (15) projects were physically visited and a total of thirtyfive (35) respondents interviewed. Lastly, in order to document different observations made during the data collection procedure, field notes were gathered. Simple random sampling was the sampling strategy employed.

There were three sections to the questionnaire. The practitioner's background information was covered in the first section. Questions on general CLP made up the second section. The third part consisted of questions targeting the factors affecting labour productivity. Observation was used on the project to collate the data collected through questionnaires as well as to check pertinent issues on labour productivity.

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Data was analysed using MS Excel and IBM® SPSS® Statistics v25. The presentation was done through tables, pie charts and graphs. The following data was collected in the study: (i) data on the level of construction practitioner's understanding, evaluation and implementation of CLP; (ii) factors viewed to affect CLP; (iii) observation of specific attributes on CLP. Photographs were taken to highlight specific items of importance to the study.

RESULTS

A. Project CLP parameters

Every responder held a minimum of an undergraduate degree, and thirty percent of them also held a master's degree in project management or construction. The experience in construction ranged from 2 years to a maximum of 22 years with the average experience being 12.5 years. The respondents were drawn from various construction professions including architects, quantity surveyors, engineers, construction managers and contractors. This is an indication that the survey identified and received feedback from practitioners of sound construction knowledge. Figure 1 shows the evaluation of respondent practitioners by profession. The highest number of construction project management practitioners were engineers (34%) while the least were construction managers (11%). It was noted though that 30% of the sample had additional training in construction project management.

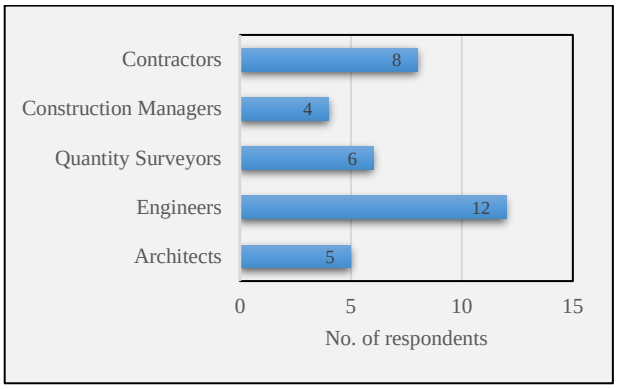

Figure 1: Evaluation of number of respondents by profession.

Figure 2 shows the number of respondents by evaluation of involvement in active construction project management. Out of the thirtyfive (35) respondents, 80% (28 respondents) were actively involved in the management of construction projects while 20% (7 respondents) were not actively engaged in construction management but were practicing consultants in construction projects. It can be surmised that all respondents were knowledgeable in construction.

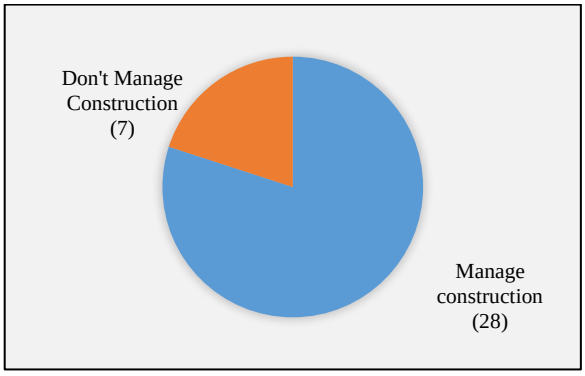

Figure 2: Involvement in construction project management

The practitioners were questioned on the source of their training on CLP (Figure 3). Out of the thirty five (35) practitioners, the highest number, twelve (34%) obtained training on CLP while executing their roles within the project as part of day to day construction management and labour supervision. The lowest source of CLP training was obtained through International Labour Organisation (ILO) seminars, 11% (4 respondents).

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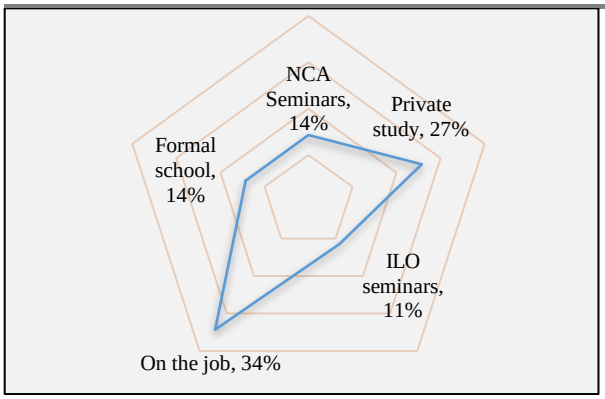

Figure 3: Source of CLP training

CLP training among the respondents from certified training institutions was through National Construction Authority (NCA) seminars, formal schooling in college and ILO seminars totaling 39%. This indicates that the Kenyan Government's initiative of increasing awareness of Labour Productivity through formal training is achieving tangible progress. However, with only 39% of the respondents having received certified training, the level of formal productivity awareness training is still substantially short of the target of 60%.

On the other hand, the informal training on CLP was through private study (27%) and on-the-job training (34%). This accounted for 61% of the training among the practitioners. The capacity of informal CLP training to yield adequacy of knowledge for globally competitiveness sufficiency is doubtful. Most of this training is enough for craft-level CLP oversight. Provision of formal training on CLP by key stakeholders of the construction industry like NCA and ILO is noted to be extremely low (25%). This is a key issue for redress by policy-makers. Similar findings on training are noted in a study of NCC semi-skilled construction workers (Wandia & Ralwala, 2024).

This survey sought to measure the level of productivity awareness amongst the practicing construction professionals (Figure 4). Attainment of basic productivity awareness was at 100% among the respondents with scores on level of awareness being: (i) below average level knowledge at 20%; (ii) average level of knowledge at 60%; and (iii) above average knowledge at 20%.

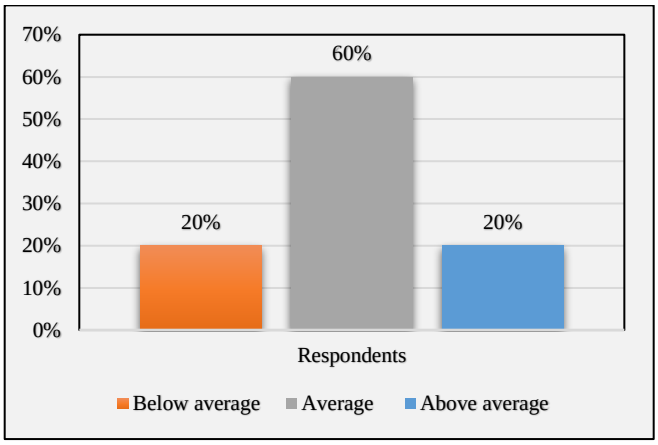

Figure 4: Evaluation of general CLP knowledge

It is doubtful that a practitioner possessing average or below-average CLP training and understanding is adequately prepared to supervise the meticulous management needed to oversee a 5% yearly productivity growth in construction projects. Particularly considering that developed economies, in contrast, hardly ever attain annual productivity increases of more than 2%.

One may assume that the only practitioners who possess sufficient training for this are the 20% who have CLP understanding that is above average. A population of at least 50% CLP knowledge-rich practitioners would be a likely critical mass for industry-wide influence. Moreover, for both local and global benchmarking and research, it is crucial to accomplish the local standardizing of metrics, developing of measuring tools and techniques as

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well as crafting of CLP management strategies.

Figure 5 shows the data collected on the measurement of CLP on projects. The survey showed that twenty eight (81%) of the practitioners undertake CLP measurement on projects based on tacit or better understanding of CLP measurement while seven (19%) do not undertake CLP measurement on projects. This confirms the evaluation of the previous section showing that 20% of the practitioners demonstrated little or no knowledge on CLP measurement.

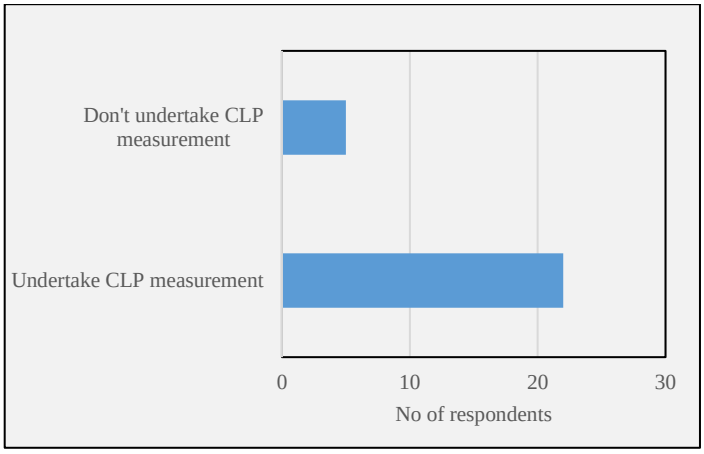

Figure 5**:** CLP measurement on projects

B. Labour Productivity Determinants.

The technique used to analyze data on labour productivity factors was Relative Importance Index (RII). Table I shows the factors that were considered for rating based on a five point Likert scale.

Table I Factors Considered for Study

Item	**Factor**
1.	Working methods
2.	Crew size and composition
3.	Availability of materials on site
4.	Management Control
5.	Weather/External Factors
6.	Availability of tools/equipment on site
7.	Level of pay
8.	Supervision
9.	Site Conditions
10.	Communication
11.	Welfare
12.	Skill of workers

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13.	Contractor Challenges
14.	Consultants
15.	Interference
16.	Turnover of labourers/ Job security
17.	Rework or repeat works
18.	Riots/insecurity/wars
19.	Quality of tools & equipment
20.	Overtime
21.	Congestion on site
22.	Leadership on the project
23.	Type of project
24.	Frequency of pay
25.	Change orders
26.	Design errors
27.	Quality Management
28.	Shortage of experienced labour
29.	Payment Delays
30.	Late arrival, Early quits & Frequent unscheduled breaks
31.	Project Location

The factors were rated by the practitioners based on their evaluation of importance in the influence of CLP. Very important, somewhat important, slightly important, significant, and not important were the scales that were used. Equation 3 displays the calculation of the Relative Importance Index.

$$\textbf{R}\text{elative Importance Index (RII)} = \frac{\Sigma w}{AN} = \left[\frac{5(n5)+4(n4)+3(n3)+2(n2)+1(n1)}{5N}\right] * 100 \ldots\ldots\ldots\ldots\ldots\ldots \text{(3)}$$

Where:

W is the weighting given to each factor by the respondents, ranging from 1 to 5 with very important = 5 and not important = 1.

A is the highest weight (i.e. 5 for this study).

N is the total number of respondents (i.e. 27 for this study).

Table II displays the top ten factors affecting Construction Labour Productivity (CLP) based on Relative Importance Index (RII). The *crew size and composition* tied with *availability of tools/equipment on site* ranked

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1st among the 31 factors with an RII of 88.15%. Concluding the 10th position of factors affecting CLP was a tie between *shortage of experienced labour* and *Late arrival, early quits & unscheduled breaks* at RII of 78.51%.

Table II Top Ten Factors Affecting Clp

Item	Factor	RII
1.	Crew size and composition	88.15
1.	Availability of tools/equipment on site	88.15
3.	Working methods	87.41
3.	Skill of workers	87.41
5.	Quality Management	85.19
6.	Availability of materials on site	84.44
7.	Management Control	81.48
8.	Leadership on the project	80.74
9.	Supervision	80.00
10.	Shortage of experienced labour	78.51
10.	Late arrival, Early quits & Frequent unscheduled breaks	78.51

Source: Author, 2024.

Crew size and composition was viewed to be very important during tasks because tasks require a definite skill and an optimum number of workers for maximum efficiency. Lack of a good enough mix of skilled and casual workers definitely leads to reduced productivity. For construction tasks, too large a number causes congestion which influences productivity negatively while at the same time a minimum crew size is equally required for optimum productivity. Previous studies have shown gang size influences CLP in such works as concrete production on-site [9], [14]. *Availability of tools/equipment on site* is also critical for achievement of high productivity since it ensures absence of unproductive time while reducing waiting time.

Working methods and *skill of workers* tied on 3rd with an RII of 87.41%. Working methods will either lead to increase or decrease of efficiency. The skills of a worker are either skilled, semi-skilled or unskilled. This is critical in the determination of the efficiency and effectiveness of crew. Though a mix of all three (3) is required on site, the expectation is that with highly skilled workers, there is an optimum level labour productivity performance.

Quality of management was 5th with RII of 85.19%. The process of handling or exerting control over objects or people is known as management. Project management errors reduce output. Management skill is an influential driver of productivity. The critical aspects of management include but are not limited to the level of management skills, management planning, leadership of management, experience of the management team and the turn-over of management.

Availability of materials was ranked 6th with RII of 84.44%. Absence or late delivery of materials causes idle time which lowers the level of productivity. At 7th rank was *Management control* which determines how the project is run administratively. This includes such aspects as procurement, training, decision-making, management style, delegation, motivation, problem solving and control of project activities. These matters are important because they directly impact on the effectiveness of project delivery and thus CLP.

Leadership on the project ranked 8th with RII of 80.74%. Leadership determines the influence that the management have in enlisting the aid and support of the project team in accomplishing the project. As such it

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directly impacts on values, synergy and morale. If the leadership is adversarial, there is likely to be demotivation and even go-slows in a project leading to reduced productivity. However, if the leadership is by example and is adjudged to be proactive, the workers are likely to pull in one direction and have high morale thus increasing increased productivity.

Supervision was ranked 9th with RII of 80.00%. Supervision has been found to be key in improvement of productivity [2], [6]. This is important for quality assurance and to ensure that idle time is eliminated. The attributes *Shortage of experienced labour* and *late arrival, early quits & frequent unscheduled breaks* tied at 10th rank with RII of 78.51%. An experienced labour force is able to work with little supervision, have less reworks, have better understanding and create better teamwork thus improving productivity by accomplishing more with less resources. *Late arrival, early quits and frequent unscheduled breaks* increase unproductive time which impacts the project negatively on productivity.

C. Observation of Pertinent CLP factors

Figure 6 shows one of the projects visited during the survey. The red arrows show materials placed next to the construction to reduce unproductive time that would otherwise be cause by material delivery waiting time. Such on-site materials arrangement enhances labour productivity. However, some of the equipment involved in material hauling is a rope (circled in red) as opposed to mechanized material delivery. The level of mechanization on a construction site has significant impact on labour productivity. Machines are able to accomplish delivery more efficiently thus reducing idle or unproductive time while at the same time releasing labourers to tend to more productive tasks.

Figure 6: Material delivery to construction area

Figure 7: Cutting reinforcement steel using hand tools.

Figure 8 shows the task of cutting reinforcement steel for structural works. Circled in red are the hand tools used for the task. The task could equally be undertaken by use of power tools which would increase the output thus increasing labour productivity while reducing cost.

CONCLUSIONS & RECOMMENDATIONS

Fundamental knowledge on Construction Labour Productivity (CLP) for implementation during project execution is instrumental in realizing savings of both time and cost. When the labor productivity is low, the end result is overruns in both. To mitigate against this, construction practitioners need to not only have sufficient knowledge on CLP but also practical tools for measurement and application including benchmarking with global best practices. The level of knowledge concerning CLP amongst practitioners is above the national average but far insufficient to reach the critical mass to foster remarkable sectorial growth. With formal CLP training of sampled practitioners at 39%, it sheds light on the training requirements that may be targeted by stakeholders.

Factors deemed important to CLP are identified and rated using RII. The top five factors by RII were *crew size and composition*, *availability of tools/equipment on site*, *working methods*, *skill of workers* and *quality management*. These would be attributes for practitioners to improve in order to reap increased on-site productivity. The study also highlights training gaps among the practitioners that may be explored by policy makers towards enabling higher performance within the construction industry. A more comprehensive study targeting a larger population across the county and in the other 46 Kenyan counties would be an area of further study.

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