*African Journal of Applied Research*
*Vol. 7, No. 1 (2021), pp. 17-26*
*http://www.ajaronline.com*
*http://doi.org/10.26437/ajar.03.2021.01*

# DETERMINING LABOUR PRODUCTIVITY FOR MASONRY WORKS ON CONSTRUCTION SITES

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***Abstract***
*Over the last decade, construction productivity has been steadily declining due to the lack of a standardized productivity database system. The aim of the study was to investigate the work technique in establishing the labour output for masonry works on construction sites. The objectives of the study were as follows: to identify the factors that influence skilled labour performance in masonry on the construction site and to determine is the labour output of masonry works. A survey and observational research approaches were employed. A questionnaire was designed to meet the requirements of the various objectives and was used as the primary instrument for data collection. A purposive and simple random sampling technique was used to select three sites and sixty respondents comprising site engineers, skilled and unskilled labourers and site foremen. The study revealed twenty-seven factors that influenced labour productivity and they were grouped into five components which were management, task, worker, temperature, and material components. The three sites visited observation recorded within the period of study, the total output area per day of blocks laid within an area of* 55.64 $m^2$ at the site is 1.26 $m^2$/gang-day *of which the gang consist of 1 mason and 2 labourers. The study's implications will eventually allow building contractors to identify the critical components to which to commit resources for contractors' capacity development.*
***Keywords****: labour. masonry. output. productivity. Construction industry.*

## INTRODUCTION

Construction productivity is constantly declining over a decade due to the lack of a standard productivity database system and ignorance of the impact of various factors influencing labour productivity (Bamfo-Agyei, Aigbavboa, & Didibhuku, 2018).

Attar, Gupta, & Desai (2012) noted that construction is a critical sector of the national economy for countries worldwide, as it historically accounts for a sizable portion of total employment and a sizable portion of total revenue.

According to Bamfo-Agyei, Aigbavboa, & Didibhuku (2018), labour is regarded as the most uncertain factor among costly project components (materials, equipment, and labour). The remaining components, materials, and equipment, are largely determined by market prices and are thus unaffected by project management.

ISSN: 2408-7920

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Over the last decade, increased labour productivity growth (measured in terms of value added per worker) has been the primary driver of Ghana's growth, outpacing demographic factors. Increased labour productivity, in turn, has been fueled by a dearth of jobs in more productive economic sectors such as construction and mining (Honorati, & Johansson de Silva, 2016).

The large inflow of primarily low-skilled labour into the trade sector explains why productivity gains slowed significantly after 2005 when the trade sector lacked the capacity to absorb the growing supply of workers and thus paid decreasing returns (Honorati, & Johansson de Silva, 2016).

Fluctuations in labour output rates have remained a significant challenge for developers and contractors for decades in determining activity durations and, as a result, inaccurate estimation of contract durations (Bin Seddeeq, Assaf, Abdallah, & Hassanain, 2019). The identified gap is in workers' understanding of tasks as a factor affecting labour productivity in construction activities involving masonry work. To overcome the obstacles contractors face, it is necessary to develop guidelines that guide contractors in achieving standard labour outputs, thereby preventing projects executed across the country from failing to meet deadlines. The purpose of this paper is to determine the labour output of the masonry works in Ghana's construction industry. The study's objectives were to identify the factors affecting skilled labour performance in masonry on construction sites and to ascertain the labour output of masonry and concrete works.

**Productivity in masonry Construction**

A more industry-specific definition that is widely accepted among stakeholders in the construction industry expresses productivity in terms of performance measurement–that is, as a measure of how effectively resources are leveraged to accomplish set targets or desired outputs (Durdyev, & Mbachu, 2018) Thus, productivity is a measure of workers' ability to produce output. The greater the output produced by a worker, the greater the worker's productivity level (Bamfo-Agyei, Aigbavboa, & Didibhuku, 2018). While there is an infinite number of definitions for productivity, they all refer to it as a comparison of input to output.

**Masonry Construction**

Mortar mixing, laying block, cutting block, and grouting are all labour-intensive activities that require a large number of workers with a variety of skills. Masonry work is physically demanding (Spielholz, Davis, and Griffith, 2006), and masons and labourers frequently lift heavy materials and stand for extended periods (Boschman, van der Molen, Sluiter, & Frings - Dresen, 2011).

Compatibility is a factor in achieving high productivity in masonry work, i.e., how masons work together to maintain production. Masons work in a variety of ways and accomplish a variety of tasks. While some masons work well together, others do not get along or their methods of operation are incompatible. The foreman attempts to form a gang of compatible workers because masons who work well together are more efficient, which can improve quality and productivity on the job (Kumar, Dijkman, & Song,2013).

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## THEORY UNDERPINNING THE STUDY

Jang, Kim, Kim, & Kim (2011) theory was used in this study; it was focused on work technique theory. The technique takes into account the following factors that affect the progress of work in reinforced concrete construction: working space, prefabrication/standardization/fieldwork, field accessibility, advance work, work method, work environment, crew size and composition, work difficulty, and work quantity.

Ghate, More, & Minde (2016) defined work study as a systematic examination of methods for carrying out activities to maximise resource utilisation. Ghate et al. (2016) reaffirmed that a work study aims to examine how an activity is carried out, to simplify or modify the method of operation to eliminate unnecessary or excess work or inefficient resource use, and to establish a time standard for performing that activity.

Harris, McCaffer, Baldwin, & Edum-Fotwe (2021) asserted that work study is subdivided into method study, which is a technique used to document work procedures, develop systems of analysis, and measure work. Time study is the process of determining the time required to complete a task to establish an output of production for a worker or machine. The purpose of this study was to establish construction labour productivity on construction sites through the use of the work technique approach.

Lema (1996) asserted the term "standard rating" refers to the average rate at which qualified workers will naturally work at a job if they follow the specified procedure and are motivated to apply themselves to their work. According to Lema (1996), standard rating results in the following ratios: basic time; standard time; standard performance; relaxation allowance; and contingency. The primary impediment to using time study techniques to study labour productivity in developing countries such as Ghana is a lack of work study experience in the construction industry.

### Factors Influencing Labour Productivity

Bamfo-Agyei, Aigbavboa, & Didibhuku (2018) identified seventy-two (72) factors affecting labour productivity on construction sites and classified them into six components: management and control, equipment and tool component, worker component, work-related conditions component, material component, and temperature component.

Thus, the outcome is justified because a lack of supervision and performance monitoring results in decreased construction productivity. Change orders, an ineffective management style, a lack of coordination among construction parties, and client influence all contribute to decreased construction productivity (Durdyev, & Mbachu, 2018).

Jang, Kim, Kim, & Kim (2011) identified thirty-six (36) factors affecting labour productivity in reinforced concrete construction and then classified them into seven major components: worker, work characteristics, work technique, equipment and material, work management, work guide, and work delay.

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Enshassi, Mohamed, Mustafa, & Mayer (2007) classified the factors affecting construction productivity into ten (10) categories, including internal labour, leadership, motivation, time, materials and equipment, supervision, project characteristics, security, and quality, and external factors.

Soekiman, Pribadi, Soemardi, & Wirahadikusumah (2011) identified thirty (30) factors affecting construction labour productivity and classified them into nine (9) categories, including design, planning and implementation, labour, supervision, material, site management, equipment, leadership and coordination, and external factors.

Bamfo-Agyei, Aigbavboa, & Didibhuku (2018) asserted that the task system was promoted as effective for labour-based work and that skilled labourers understood it well enough to perform the tasks assigned to them effectively. Additionally, supervision was identified as a factor that must be addressed if labour productivity is to be achieved.

## RESEARCH METHODS

A survey and observational research approaches were employed. A set of questionnaires was designed to satisfy the requirements of the various objectives and was used as one of the data collection instruments. Three sites and sixty respondents were chosen using a purposive and simple random sampling technique. The respondents included site engineers, skilled and unskilled labourers, and site foremen. Fifty (50) sets of questionnaire were retrieved, representing an 83.33% response rate. The collected data were analysed with descriptive statistics. Every activity associated with the blockwork was observed. The precise time the workers spent performing their duties was recorded.

## RESULTS AND DISCUSSION

*Factors that Influence Labour Performance in Masonry Work*

Tables 1 to 5 classify twenty-seven factors affecting labour productivity in masonry work in the building construction industry into five components.

*Table 1. The Factors that Influence Skilled Labour Performance in Masonry to Management Component on Construction Site.*

| Factors | Mean | S.Dev | Rank |
|---|---|---|---|
| Organisation encourages competition in production | 3.12 | 1.054 | 1st |
| Organisational size and maturity | 3.00 | 1.080 | 2nd |
| Labour management relations | 2.96 | 1.020 | 3rd |
| Degree of supervision | 2.92 | 0.862 | 4th |

Source: Fieldwork, 2020

In terms of the Management component, it included four variables, as shown in Table 1, the first of which was Organization encourages competition in production, which received a mean score of

ISSN: 2408-7920

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3.12. While the firm's size and maturity, as well as its labour management relationships, all affect the skilled labour performance in masonry. The management and control component is critical in delegating tasks and instructions to employees. This factor's impact is consistent with the findings of Sibande & Agumba (2018), who stated that construction managers must provide detailed and realistic schedules to on-site supervisors for them to monitor and coordinate site work.

*Table 2. The Factors that Influence Skilled Labour Performance in Masonry to Task Component on Construction Site.*

| Factors | Mean | S.Dev | Rank |
|---|---|---|---|
| Type, scope, layout and complexity of the project | 3.92 | 0.051 | 1st |
| Gang size | 3.76 | 0.080 | 2nd |
| Length of blockwork to be laid a day | 3.64 | 0.058 | 3rd |
| Height of blockwork to be laid a day | 3.52 | 0.062 | 4th |
| Composition (age, sex, skill and training) of the workforce | 3.49 | 1.083 | 5th |
| Construction method | 3.33 | 1.107 | 6th |

*Source: Fieldwork, 2020*

As shown in Table 2, the task component had six variables, with the type, scope, layout, and complexity of the project having a significant impact on the component's mean score of 3.92. Following that, the gang size, length, and height of blockwork that could be laid in a day all contributed to the labour productivity of both skilled and unskilled labourers performing masonry work on-site. Additionally, the age of the workers and the method of construction can affect the productivity of labour-intensive works in Ghana. These findings corroborate those of (Bernold, & AbouRizk, 2010), who emphasised the importance of workers adhering to construction specifications and ensuring the quality of work delivered.

*Table 3. The Factors that Influence Skilled Labour Performance in Masonry to Worker Component on Construction Site.*

| Factors | Mean | S.Dev | Rank |
|---|---|---|---|
| Physical fatigue | 3.80 | 0.031 | 1st |
| Worker innate ability-his physical and mental energy. | 3.56 | 0.042 | 2nd |
| Passion for the job | 3.50 | 0.061 | 3rd |
| Low wage level | 3.48 | 0.082 | 4th |
| Social and physiological condition of work | 3.35 | 0.099 | 5th |

*Source: Fieldwork, 2020*

Five variables influenced skilled labour performance in masonry to the Worker Component on construction sites, as shown in Table 3. Physical fatigue; the worker's innate ability—his physical and mental energy; job passion; low wage level; and the social and physiological conditions of work all influenced the worker significantly. Due to the labour-intensive nature of the construction industry, the workforce factor plays a significant role in the implementation process (Siyepu, 2016). This also confirms Ulubeyli, Kazaz, & Er's (2014) finding that workers affect productivity;

ISSN: 2408-7920

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even under identical conditions, different productivity rates can be obtained due to changes in a variety of factors such as motivation, wage, and accident.

*Table 4: The Factors that Influence Skilled Labour Performance in Masonry to Material Component on Construction Sites.*

| Factors | mean | S.Dev | Rank |
|---|---|---|---|
| Texture of material | 4.10 | 0.081 | 1st |
| Availability of material | 3.95 | 0.065 | 2nd |
| Type of material | 3.61 | 0.049 | 3rd |

*Source: Fieldwork, 2020*

Concerning the material component, three variables were identified as affecting skilled labour performance in masonry to the material component on construction sites. These variables are the texture of the material, its availability, and its type. This is consistent with Lessing, Thurnell, & Durdyev's (2017) findings that workers spend more time working with low-quality materials than they do with suitable materials.

*Table 5. The Factors that Influence Skilled Labour Performance in Masonry to Temperature Component on Construction Sites.*

| Factors | Mean | S.Dev | Rank |
|---|---|---|---|
| Sunshine | 3.64 | 0.031 | 1st |
| Rainfall | 3.55 | 0.045 | 2nd |
| Relative humidity | 3.36 | 0.079 | 3rd |

*Source: Fieldwork, 2020*

As shown in Table 5, the temperature component includes three variables: sunshine, rainfall, and relative humidity, all of which affect labour productivity on-site. Inappropriate weather conditions can result in damage and thus project schedule delays, as has been reported by (Moselhi, & Khan, 2010). The optimal temperature for site productivity was determined to be 22°C, and it is observed that any increase in temperature (up to 25°C) has a negative effect on productivity (Rogers, Edwards, & Perera, 2018).

*Determining the labour output for masonry work*

This session summarises the labour output for masonry work as observed at the research sites. Tables 6–8 detail the type of work performed by the gangs observed.

ISSN: 2408-7920

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*http://doi.org/10.26437/ajar.03.2021.01*

*Table 6 Labour productivity at construction site A.*

| Time | Activity | Gang Size | Area of work Done(M) |
|---|---|---|---|
| 7:30 am to 11:00 am | Laying of blocks | 1 mason<br>2 Labourers | 0.30 |
| 11:08am to 11:35 am | Laying of blocks | 1 mason<br>2 labourers | 0.05 |
| 11:45 am to 12: 08 pm | Laying of blocks | 1 mason<br>2 labourers | 0.25 |
| 12:23 pm to 12:52 pm | Laying of blocks | 1 mason<br>2 labourers | 0.70 |

*Source: Fieldwork, 2020*

Observations made during the study period indicated that the total output area per day of blocks laid within a 1.30 $m^2$ area at the site is 0.11 $m^2$/gang-day, with each gang consisting of one mason and two labourers.

*Table 7: Labour productivity at construction site B.*

| Time | Activity | Gang Size | Area of Work Done (M) |
|---|---|---|---|
| 10:38am – 1:37pm | Laying of blocks | 1 mason<br>2 Labours | 5.10 |
| 11:36am -1:40pm | Laying of blocks | 1 Mason<br>2 Labourers | 5.49 |
| 11:36am-1:49pm | Laying of blocks | 1 Mason<br>2 Labourers | 7.20 |
| 11:36am-1:50pm | Laying of blocks | 1 Mason<br>2 Labourers | 7.20 |
| 1:36pm-01:50pm | Laying of blocks | 1 Mason<br>2 Labourers | 1.59 |
| 3:00pm – 4:40pm | Laying of blocks | 1 Mason<br>2 Labourers | 3.80 |

*Source: Fieldwork, 2020*

ISSN: 2408-7920

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Observations made during the study period indicated that the total output area per day of blocks laid within a 30.38 $m^2$ area at the site is 1.68 $m^2$/gang-day, with each gang consisting of one mason and two labourers.

*Table 8: Labour productivity at construction site C*

| Time | Activity | Gang Size | Area of Work Done(M) |
|---|---|---|---|
| 3:15pm-6:04pm | Laying of blocks | 1 Mason<br>2 Labourers | 7.82 |
| 3:25pm-5:50pm | Laying of blocks | 1 Mason<br>2 Labourers | 7.82 |
| 3:53pm-6:03pm | Laying of blocks | 1 Mason<br>2 Labourers | 5.38 |
| 4:15pm- 5:23pm | Laying of blocks | 1 Mason<br>2 Labourers | 2.94 |

*Source: Fieldwork, 2020*

Observations made during the study period indicated that the total output area per day of blocks laid within a 23.96 $m^2$ area at the site is 1.99 $m^2$/gang-day, with each gang consisting of one mason and two labourers.

With regards to the three sites visited, observations made during the study period indicate that the total area of blocks laid at the site is 55.64 $m^2$, or 1.26 $m^2$/gang-day, with the gang consisting of one mason and two labourers.

## CONCLUSION

Thus, the general finding was sustained, namely that firms' labour productivity is directly related to the influence of exogenous variables on predicting overall labour productivity in developing countries' construction industries, using masonry as a case study.

The relationships among four exogenous components and the endogenous factor were found to be statistically significant. Additionally, the result indicated that all latent factors accurately predicted the aggregate labour productivity of road construction firms.
Based on the various sites visited, it was determined that contractors should consider the following factors to increase productivity and complete work within the anticipated time frame:

i. The composition of the gang (that is the number of workforces tasked to an activity, increase in the workforce brings about speed and increase the output)
ii. Skill disparity between gangs.
iii. Inappropriate task sequencing

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iv. Inadequate access to tools and materials.

**Contribution to the Body of Knowledge**

The study's theoretical implication is that it was discovered in the literature that there are still disparate definitions and understandings of how labour productivity is calculated. This has historically resulted in a restricted view and conceptualization of firms' labour productivity. Additionally, there has been no agreement on how to measure firms' labour productivity in the construction industry. However, in the current study, the literature on the determinants of firms' labour productivity was reviewed and synthesised. A five-component model was established to predict the labour productivity of masonry work on construction sites. Temperature, material, management, task, and workers were identified as these components. It is therefore recommended that these factors affecting construction labour productivity, with a particular emphasis on operationalization, serve as the foundation for further refinement of the concept, thereby benefiting construction firms in Ghana and other developing countries.

Additionally, the study's findings demonstrated the extent to which the five constructs influence the labour productivity of indigenous construction firms in Ghana's construction industry. The study's findings will assist the Association of Building and Civil Engineering Contractors of Ghana (ABCECG) in determining the criteria for prioritising support for indigenous construction firms' productivity in Ghana's construction industry. It will eventually enable the ABCECG to identify critical areas for contractor capacity development.

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ISSN: 2408-7920