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COVID-19-related factors affecting construction labour productivity in Zimbabwe

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ABSTRACT

The COVID-19 pandemic aggravated the underlying productivity challenges in the construction sector. However, not much is known regarding how the pandemic affected labour productivity in developing countries such as Zimbabwe. Therefore, this study investigates the COVID-19-related factors affecting construction labour productivity in Zimbabwe. A survey design entailed the distribution of an online questionnaire to construction professionals in Bulawayo and Harare. The data was analyzed using descriptive statistics. Factor analysis was also utilized to reveal significant factors affecting construction labour productivity. Factor analysis revealed nine (9) significant factors contributing to reduced labour productivity during the COVID-19 pandemic, namely: poor project planning and management issues; permits and inspection delays; cash flow and payment challenges; compliance with COVID-19 health and safety (H&S) protocols; disruption of project activities; lack of empowerment and capacity building; material supply disruptions; labour supply disruptions; and design changes and poor information transfer. Construction stakeholders can use the results of this study to design appropriate interventions to prevent/reduce pandemic-related productivity losses. However, differences in insights due to demographic variables were not determined to enable targeted interventions. This study is among the emerging studies investigating how the COVID-19 pandemic affected construction labour productivity from a developing country perspective, with the consequent determination of appropriate interventions envisaged.

Keywords: COVID-19, factors, construction productivity, Zimbabwe

1. INTRODUCTION

Increasing labour productivity in construction is crucial for realizing the economic growth and sustainability of the construction business. In the construction sector, where most projects are labour-based, productivity growth is crucial to enhance project performance. Kapsos (2021) observes that labour productivity growth enhances business profitability. According to Dozzi and AbouRizk (1993), labour efficiency is the basis of most tender estimates and is used to measure and monitor performance. Despite the crucial place of labour productivity in enhancing project and business performance, the construction industry is characterized by a systemic labour productivity challenge (Adebowale and Agumba, 2021; Chigara and Moyo, 2014). As summarized by Adebowale and Agumba (2021), construction labour productivity has fallen behind other industries in most countries and has declined continuously for decades. The challenge is exacerbated by the coronavirus disease of 2019 (COVID-19) (McLin et al., 2020; Rubin, 2020).

COVID-19 is an infectious disease which was first discovered in Wuhan Province in China in December 2019. It was declared a public health emergency by the World Health Organisation (WHO) on 11 March 2020 (ILO, 2020). The COVID-19 pandemic has an enormous social and economic burden on society, workers and enterprises. As of 20

December 2021, 276,366,657 people had been infected, and 5,372,513 had died globally (Johns Hopkins University, 2021). Zimbabwe recorded 195,079 COVID-19 infections and 4,805 deaths (Ministry of Health and Childcare, 2021). To preserve public health and protect workers' H&S, the Government of Zimbabwe, in consultation with the WHO, adopted several measures such as the closure of national borders, the shutdown of main economic activities, restricted movement and gatherings, the introduction of additional public health protocols such as social distancing and handwashing (Chigara and Moyo, 2021a).

Nonetheless, essential construction activities such as rehabilitation of hospitals and infrastructure were allowed to continue under COVID-19-induced protocols and conditions (McLin et al., 2020; Chigara and Moyo, 2021a). However, the radical shifts introduced in the organization of work to limit the spread of the virus had several ramifications for construction labour productivity. In the United Kingdom (UK), Rubin (2020) established that the pandemic and response efforts caused labour productivity losses of around 35%. In the United States of America (USA), McLin et al. (2020) report that construction labour productivity was impacted by nearly 20% because of the COVID-19 pandemic. Related studies conducted in Jordan (Bsisu, 2020), the USA (Alsharef et al., 2021) and Zimbabwe (Chigara and Moyo, 2021b) affirm the adverse effect of COVID-19 on construction labour productivity. Economically, a reduction in labour productivity adversely affects overall project performance through its impact on project schedules and project costs (King and Rahman, 2021; Rahman et al., 2021).

Given the potential impact of COVID-19 on construction labour productivity, McLin et al. (2020) and Rubin (2020) quantified the magnitude of productivity loss. While these studies are crucial to demonstrate the magnitude of the problem, Enshassi et al. (2007) argue that improving labour productivity requires understanding the drivers of productivity loss. However, studies investigating the significant drivers of construction labour productivity loss during the COVID-19 pandemic in Zimbabwe and other developing countries remain limited. Therefore, this study sought to bridge this gap by investigating the perceptions of construction professionals in Zimbabwe regarding the COVID-19-related factors affecting labour productivity. Furthermore, given the recurrence of pandemics and the uncertainty surrounding the COVID-19 pandemic, knowledge of the factors affecting labour productivity during this pandemic is critical to inform construction stakeholders and policymakers regarding interventions required to promote productivity growth in construction during and after the pandemic.

2. THE REVIEW OF RELATED LITERATURE

This section will present the study's theoretical background under the following subheadings.

2.1 Overview of covid-19 control measures in construction

COVID-19 is an infectious disease caused by SARS-COV-2 (American Industrial Hygiene Association, AIHA, 2020). It spreads rapidly through airborne exposure (AIHA, 2020) when a person comes into close contact (within 2m) with an infected person and indirectly through contact with a surface recently contaminated with respiratory droplets (Workplace Health and Safety Queensland, 2020; WHO, 2020). The risk of COVID-19 infection in construction is amplified by the nature of work which calls for workers to work in close contact and share common spaces such as elevators, lunch and break areas, and sanitation facilities (AIHA, 2020). An emerging body of evidence shows that construction workers have a higher risk of COVID-19 infection than workers in other sectors (Allan-Blitz et al., 2020; Alsharef et al., 2021; Pasco et al., 2020). The risk of serious illness is also high in individuals with underlying health conditions and those above 60 years (ILO, 2020). McLin et al. (2020) estimate that a 10% impact on productivity results in a 100% impact on profitability.

To limit the spread of COVID-19 infections, several interventions were introduced at national and sectoral levels. At the national level, measures such as the closing of national borders, the shutdown of primary economic activities, restrictions on movement and large gatherings, quarantine procedures for infected workers, and the introduction of additional public health protocols such as social distancing and handwashing were adopted (Chigara and Moyo, 2021a). Furthermore, the promulgation of Statutory Instrument 77 of 2020: Public Health (COVID-19 Prevention, Containment, and Treatment) Regulations provided the legal force to enforce the implementation of these measures. In addition, the government spearheaded the COVID-19 vaccination programme. At the sector level, the construction industry adopted several measures including implementation of social distancing requirements, health screening of workers and provision of personal protective equipment (PPE), amongst others. While these measures are essential to limit the spread of the virus, notable shortcomings in the implementation of the measures, distribution of vaccines, and potential waning of vaccine efficacy against new COVID-19 variants suggest that the world is far from reverting to normalcy. This calls for the continuation of some public health measures to limit the spread of the virus and its effects on workers and the public.

2.2 Construction labour productivity

Labour productivity contributes immensely to the realization of project objectives in construction (Chigara and Moyo, 2014). However, there is a surfeit of evidence identifying low labour productivity among the key challenges affecting construction projects (Enshassi et al., 2007; Chigara and Moyo, 2014). According to Kapsos (2021), productivity is a measure of how efficiently inputs such as labour, capital, land, energy, and other intangible factors are used to produce goods and services. Therefore, labour productivity is a crucial element of construction productivity. A fall in labour productivity can adversely affect project performance by influencing project duration and cost. Van Biesebroeck (2015) define labour productivity as the value of output that a worker, a firm, an industry, or a country has produced per unit of labour input. In the long term, improving labour productivity is critical to improving the economic development of project performance, firm competitiveness and profitability, and standard of living (Kapsos, 2021). Despite this, the construction sector is characterized by a systemic challenge of declining labour productivity due to several factors/challenges. The COVID-19 pandemic is a new challenge to construction labour productivity. Understanding the various pathways/channels through which the pandemic affects labour productivity is critical to developing strategies to reduce inefficiencies and more effectively manage construction labour (Hamza et al., 2019). While several studies have been conducted to identify factors affecting construction labour productivity, only a few have addressed the labour productivity challenge during the COVID-19 pandemic. Since improving labour productivity is a concern for any profit-oriented business (Enshassi et al. 2007), knowledge of the factors affecting labour productivity during the COVID-19 pandemic is essential to identify key focus areas to foster productivity growth during and after the pandemic.

2.3 The impact of covid-19 on construction labour productivity

Emerging evidence suggests that the COVID-19 pandemic aggravated the labour productivity challenge in the construction industry. To limit the spread of the disease on construction sites, radical shifts were introduced directed at work organization. These measures had concomitant effects on labour productivity. Chigara and Moyo (2021b) report that the stringent measures adopted to limit the spread of the virus reduced construction labour productivity between a near major to a major/major extent. During another study in the USA, Alsharef et al. (2021) established that the pandemic contributed to a significant reduction in productivity rates in the construction industry.

King et al. (2021) examines the critical pandemic impacts (CPI) on the architecture, engineering and construction (AEC) organizations using a systematic literature review and in-depth interviews with 40 AEC practitioners. The study reports that the pandemic and response efforts reduced construction productivity. In Ghana, Amoah et al. (2021) investigated the impact of COVID-19 on small construction firms using open-ended questionnaires administered to 30 respondents from selected firms. The study's main findings are that workers' productivity levels dwindled and consequently escalated project costs and completion time. A related study conducted in the construction industry in Vietnam reveals that COVID-19 adversely affected construction labour productivity (Nguyen et al., 2021). In another study in the UK, Rubin (2020) observes that the COVID-19 pandemic generated productivity losses amounting to 35% on construction projects. Finally, using a case study of 45 projects implemented during the pandemic in the UK, the Construction Manager (2020) reports that the COVID-19 pandemic caused extra productivity losses of around 15% on UK construction sites.

The COVID-19 pandemic affected construction labour productivity in various ways. According to Rubin (2020), the pandemic affected labour productivity through labour and material disruptions, social distancing requirements, poor transfer of design information while remote working and poor planning. In a related study in the UK, the Construction Manager (2020) reports that labour shortages, the impact of social distancing, poor transfer of design information while remote working, late deliveries, delays in the arrival of domestic materials, and poor planning and inefficiency were the main factors accounting to productivity losses.

Bloom et al. (2020) investigates the impact of COVID-19 on productivity in the UK. The findings of the study reveal that the pandemic reduced total factor productivity by 5% in the fourth quarter of 2020. The authors observe that the re-organization of production processes in response to the pandemic shock has implications for productivity and factor usage. McLin et al. (2020) examine the impact of the pandemic on the productivity of field and office personnel in the USA. The results indicate that contractors experienced an 8.9% productivity loss due to pandemic mitigation activities. McLin et al. (2020) argue that the time lost complying with the COVID-19 protocols could be devoted to production activities. The job-site pandemic mitigation measures to limit exposure to the virus, such as training, health screenings, cleaning and disinfecting, job site access and administration, significantly affected labour productivity (McLin et al., 2020). In a related study, investigating the impact of the COVID-19 pandemic on civil engineers, Bsisu (2020) states that approximately 32% of the surveyed engineers experienced a decrease in productivity attributed to work-from-home (WFH) arrangements.

Agyekum et al. (2021) adopted a case study design to investigate the impact of COVID-19 on the construction sector in Ghana by conducting nine interviews with professionals from selected firms. The findings of this study reveal that the pandemic affected the working rate and productivity due to the need to comply with H&S protocols relative to COVID-19, such as social distancing. In Malaysia, King et al. (2021) points out that a reduction in labour productivity is the leading critical impact of the COVID-19 pandemic on the AEC sector. The study identified social distancing requirements, labour shortages, poor transfer of information from remote working, and late delivery or unavailable materials due to disruptions in global supply chains as the leading factors contributing to reduced labour productivity.

Quezon and Ibanez (2021) use a survey design among construction professionals in road construction implementation to identify significant factors contributing to low construction labour productivity during the period December 2020 and 31 January 2021 in the Philippines. The main findings of this study suggest that the absence of health workers on construction sites, lack of safety engineers, schedule compression, lack of labour safety standard practice, and lack of empowerment (training/seminar) were the leading factors

contributing to low labour productivity during the pandemic. In the USA, Alsharef et al. (2021) studied the early impacts of COVID-19 on the construction industry using interviews with 34 construction professionals. The study reports that COVID-19 contributed to a fall in productivity in the construction industry because of delays in the supply of materials, inspection delays, shortage of materials, PPE shortages, safety prioritized over productivity, workforce reduction per social distancing requirements, worker absenteeism, staggering of work operations, revisions to the original schedule, additional coordination efforts, cash flow and payment challenges, material delays and availability, and inspection and permitting delays as some factors contributing to reduced efficiency and productivity rates (Alsharef *et al.*, 2021). In Ghana, Amoah et al. (2021) examine the impact of COVID-19 on small construction firms. The results of the study reveal that workers experienced a fall in productivity because of stay-at-home mandates for workers, safety screening requirements for the few workers allowed on-site, employees showing up late for work because of transport challenges, and absenteeism of workers because of the fear of contracting the virus.

Table 1 presents a summary of the COVID-19-related factors affecting labour productivity in construction.

Table 1: COVID-19-related factors affecting construction labour productivity

Author	Country	Research method adopted	Insights on the COVID-19-related factors affecting labour productivity
Agyekum et al. (2021)	Ghana	Interviews	Compliance with COVID-19 H&S protocols
Rubin (2020)	UK	Literature review	Labour supply disruptions Late delivery or unavailability of materials Social distancing requirements Poor transfer of design information Poor planning.
The Construction Manager (2020)	UK	Case study	Labour shortages Poor transfer of design information Late deliveries of materials Poor planning
Bsisu (2020)	Jordan	Surveys	Work from home (WFH) arrangement
Bloom et al. (2020)	UK	Surveys	Re-organization of production processes
McLin et al. (2020)	USA	Survey	Job site pandemic mitigation measures
Alsharef et al. (2021)	USA	Interviews	Delays in supply of materials Shortage of materials Inspection delays Prioritization of H&S over productivity Reduced workforce per social distancing requirements Absenteeism of workers Staggering work operations Revisions to the original schedule Cash flow and payment challenges
Amoah et al. (2021)	Ghana	Open-ended questionnaire	Stay at home mandates Safety screening requirements on site, Workers showing up late at work because of transport challenges Absenteeism of workers
Quezon and Ibanez (2021)	Philippines	Survey	Absence of health workers on construction sites Schedule compression Lack of labour safety standard practice Lack of empowerment (training/seminar).

Table 1 summarises the channels through which the pandemic and response efforts affected construction labour productivity. While these studies provide essential building blocks for construction stakeholders to respond to the effects of the pandemic, the studies are still very few to provide a complete understanding of the significant challenges affecting construction labour productivity. In addition, the geographical distribution of the studies is skewed toward the developed world, while fewer studies have been conducted in Southern Africa, specifically Zimbabwe. During an earlier study, Hamza et al. (2019) observed that studies on construction labour productivity are biased towards Asia (58%), North America (15%), Europe (13%), and Africa (10%). Therefore, this study sought to expand the boundaries of knowledge on this subject from a developing country's perspective by investigating the perceptions of construction professionals in Zimbabwe regarding the COVID-19-related factors affecting labour productivity. This is consistent with the realization that different countries' varying social, political, and legislative environments call for country-specific studies to inform country-specific interventions.

3. RESEARCH METHOD

A survey research design was adopted in which an online questionnaire was distributed to construction professionals selected from contractors and consulting firms based in Bulawayo and Harare. A survey research design is preferred because it provides a quantitative description of the attitudes or opinions of a population by studying a sample of that population (Creswell and Creswell, 2018). The 2020 database of construction and consultant firms shows that over 80% of registered contractors and consulting firms in Zimbabwe are located in the two cities.

The population and sample - The population comprises architects, quantity surveyors, civil engineers, construction/project managers, and construction H&S managers. The total population is one hundred and eighty-six (186) firms distributed as 67 contractors in categories A, B, and C (medium to large), 54 Architects, 43 Engineers and 22 Quantity Surveyors. The selected respondents were members of the Construction Industry Federation of Zimbabwe (CIFOZ), Institute of Architects Zimbabwe (IAZ), Zimbabwe Association of Consulting Engineers (ZACE) or Zimbabwe Institute of Quantity Surveyors (ZIQS). Given the lack of a professional body representing construction project managers in Zimbabwe, the study adopted Walker's (2015) advice that project managers for building projects may be drawn from any of the professions associated with construction. Considering that the population is relatively small, a census was adopted in selecting respondents.

Questionnaire design and administration - Given the COVID-19 restrictions on movement, an online questionnaire hosted on the Survey Monkey platform was used to collect primary data for the study. An online questionnaire can be accessed from home or office (Bloom et al., 2020) and has low administration costs and is flexible regarding how the questions are displayed (O'Leary, 2017). Conversely, online surveys suffer from a low response rate (O'Leary, 2017). The questionnaire had two sections. The first section required respondents to record their demographic and socio-economic data, such as designation, education, gender, and work experience. The second section comprised a closed-ended question where respondents were asked to rate, on a five-point Likert scale (1 = minor, 2 = near minor, 3 = moderate, 4 = near major, and 5 = major), the extent to which COVID-19 related factors adversely affected construction labour productivity in Zimbabwe. A five-point Likert scale was used because it maintains the response categories meaningful to respondents (Losby and Wetmore, 2012).

Before distributing the questionnaires, five construction experts were invited to review the questionnaire in terms of (a) the ability of the questions to generate the type of

information they are required to collect; and (b) relevance and adequacy of the literature-generated COVID-19 related factors with a negative effect on construction labour productivity. The experts were purposively selected from academia (2) and the construction industry (3) based on their knowledge of questionnaire design, experience in the industry (>10 years), and academic qualifications (Master's degree in construction/built environment-related qualification) (Feil and Khan, 2015). The final questionnaire incorporated reviewers' comments and was distributed via emails and on platforms of construction professionals with a web link to a survey. The survey was open between 25 November 2020 and 15 December 2020, and gentle reminders were sent to respondents after a week from the date the survey was first distributed.

Data analysis - The Statistical Package for Social Sciences (SPSS) software (24.0) was used for data capturing and statistical analysis. The data was initially analyzed through descriptive statistics, such as computing measures of central tendency in the form of mean scores (MSs) and frequencies to facilitate the ranking of the factors. Through ranking of the variables, the most significant factors were identified, which could help to develop recommendations (Raoufi and Fayeki, 2021). As guided by Ikediashi et al. (2012), a midpoint score of 3.00 $[(1+2+3+4+5)/5 = 3)]$ was used to identify significant factors. The standard deviation was used to facilitate rank differentiation where two or more factors had the same MS (Doloi et al., 2012). Cronbach's alpha was used to assess the internal consistency reliability of the Likert-type scale of the questionnaire. A Cronbach's alpha coefficient ranges from 0.0 to 1.0, and the closer the coefficient to 1.0, the greater the internal consistency of the items in the scale (Gliem and Gliem, 2003). Exploratory factor analysis was used to reveal greater insight among several correlated but seemingly unrelated attributes into fewer underlying factors (Doloi et al., 2012).

4. RESULTS AND DISCUSSIONS

4.1 Sample stratum and response rate

One hundred and eighty-six (186) questionnaires were distributed, and fifty-five (55) were returned, representing a 29.6% response rate. The response rate is consistent with the observations of earlier studies that the response rate for questionnaire surveys in construction ranges from 20 to 30% (Akintoye and Fitzgerald, 2000). Notably, scholars consider a sample of 30 to be adequate for statistical analysis and making meaningful conclusions (O'Leary, 2017). In addition, the demographic characteristics of the respondents, such as designation, experience, and qualifications, suggest that the study benefited from experienced and knowledgeable respondents and the results provide valuable and important insights which can inform policy and practice to reduce the impact of the pandemic on the sector and particularly labour productivity.

The demographic analysis shows that male respondents were 78.9% while female respondents constituted 21.2%. The gender distribution is consistent with the ZimStat (2019) survey; where females constitute 11.8% of wage/paid employment in the non-agricultural sector. In terms of educational qualifications, the analysis shows that 50.9% of the respondents had an Honours degree, 38.2% with a Master's degree, 7.3% with a National Diploma, and 3.6% with a Higher National Diploma. Regarding the designation, 32.7% of the respondents were Project/Construction Managers, followed by Quantity Surveyors (29.1%) and Engineers (16.4%). The respondents were selected from Contractors (38.8%) and consulting firms: Architects (9.1%), Engineers (16.4%), Project Managers (14.5%) and Quantity Surveyors (21.8%).

Table 2: Demographic profile of respondents

Characteristic	Description	Frequency	Per cent (%)
Gender	Male	43	78.2
	Female	12	21.8
	Total	***55***	**100**
Educational background	Bachelors' degree	28	50.9
	Master's degree	21	38.2
	Higher national diploma	2	3.6
	National Diploma	4	7.3
	Total	***55***	**100**
Nature of organization	Architects	5	9.1
	Contractors	21	38.2
	Engineers	9	16.4
	Project managers	8	14.5
	Quantity surveyors	12	21.8
	Total	***55***	**100**
Respondents' profession/ Designation / Role	Director/Partner /Chief Executive Officer	7	12.7
	Project Manager	18	32.7
	Health and Safety Officer / Manager	2	3.6
	Quantity Surveyor	16	29.1
	Architect	3	5.5
	Engineer	9	16.4
	Total	***55***	**100**
Number of years working in the construction industry	0 - 5 Years	11	20.0
	6 -10 Years	20	36.4
	11 - 15 Years	17	30.9
	> 15 Years	7	12.7
	Total	***55***	**100**

4.2 Reliability of the scales

Before conducting statistical analysis, reliability analysis for the 36 factors was conducted. A Cronbach's alpha of 0.945 was obtained. Given that Cronbach's alpha is greater than the minimum threshold value of 0.70 (Hair *et al.*, 2010), the scale can be considered reliable.

4.3 COVID-19 related factors affecting construction labour productivity

Table 3 presents the COVID-19-related factors affecting labour productivity in the construction sector in Zimbabwe.

Table 3: COVID-19-related factors affecting construction labour productivity in Zimbabwe

Factors	MS	SD	Rank
Disruptions of the global supply of materials	4.60	0.78	1
Shortage of materials in the domestic market	4.51	0.77	2
Inadequacies of public transport systems	4.49	0.74	3
Travel restrictions limiting personnel availability	4.35	0.87	4
Delays in the delivery of materials	4.33	0.92	5
Delays in issuing permits	4.23	1.05	6
Changes in regulations (e.g., the introduction of curfews)	4.20	1.01	7
Late payment of salaries and wages	4.13	1.04	8
Complying with COVID-19 mitigation measures	4.09	1.08	9

Reduced working hours	4.09	1.21	10
Low remuneration	4.07	0.94	11
Disruptions of the global supply of equipment	4.07	1.07	12
Work stoppages / disruptions	4.02	1.13	13
Temporary project suspension	4.00	1.22	14
Increased on-site H&S measures	3.96	1.04	15
Inadequate training in COVID-19 protocols	3.87	0.94	16
Shortage of labour	3.96	1.04	17
Restrictive working conditions	3.98	1.03	18
The poor motivation of workers	3.82	1.07	19
Reduced number of on-site workers	3.80	1.18	20
Delayed certification visits and inspections	3.94	1.07	21
Inadequate adoption and use of technology	3.91	1.08	22
Inadequate materials procurement planning	3.76	1.19	23
Labour inefficiency	3.75	0.99	24
Worker absenteeism	3.73	1.15	25
Poor transfer of design information	3.67	1.23	26
Inadequate site welfare provisions	3.67	1.09	27
Inability to provide adequate access to sites	3.62	1.16	28
Inadequate H&S provisions	3.58	0.98	29
Supervisory incompetence in COVID-19 protocols	3.56	1.20	30
Inadequate site layout planning relative to COVID-19 requirements	3.53	1.22	31
Poor project management practice	3.42	1.21	32
Poor coordination of project team and activities	3.38	1.30	33
Poor communication	3.28	1.08	34
Inadequate use of plant and equipment	3.25	1.21	35
COVID- 19 induced design changes	3.11	1.33	36
Composite MS	**3.88**	**0.63**	

Notes: MS = Mean Score, SD = Standard deviation.

Table 3 shows that the mean scores (MSs) for all the factors are greater than the midpoint score of 3.00, which suggest that respondents deem all the factors to have a major as opposed to a minor effect on labour productivity. A composite mean score (MS) of 3.88 indicates that the respondents deem the factors to have a moderate to a near major / near major contribution to reduced construction labour productivity.

The factors ranked 1st to 6th have MSs > 4.20 ≤ 5.00, which suggests that respondents deem these factors to affect construction labour productivity between a near major to a major/major extent. The variables in this cluster include disruptions in the global supply of materials, shortage of materials supply in the domestic market, inadequacies of public transport systems, travel restrictions limiting personnel availability, delays in the delivery of materials, and delays in issuing permits. These results highlight those disruptions in the supply of construction resources, such as materials and labour, had a major effect on labour productivity during the COVID-19 pandemic. The global shutdown of manufacturing and the closure of international boundaries affected the supply of materials from international sources. At a local level, restrictions on local travel, the nationalization of the public transport system and a shutdown of economic activities affected the smooth movement of labour to construction sites and the supply of materials from local firms. The results highlight the risk of over-dependence on global markets for the supply of materials. The results reinforce the findings of Rubin (2020) and Alsharef et al. (2021), which show that late delivery and non-availability of materials reduced labour productivity.

The factors ranked 7th to 32nd have MSs > 3.40 ≤ 4.20, suggesting that respondents deem the factors to have a moderate to a near major / near major effect on construction

labour productivity. The top five factors in this cluster are changes in regulations (e.g., introduction of curfews), late payment of salaries and wages, complying with COVID-19 mitigation measures/protocols (such as health screening, cleaning and disinfecting, job-site access and administration), reduced working hours, and low remuneration. The results confirm past studies that job-site COVID-19 mitigation measures affected labour productivity (McLin et al., 2020).

The factors ranked 33rd to 36th have MSs > 2.60 ≤ 3.40, which shows that respondents deem that poor coordination of project team, poor communication, inadequate use of plant and equipment, and COVID-19-induced design changes affect construction labour productivity between a minor to a moderate/moderate extent. However, these factors are ranked low, their MSs > 3.00, which suggests that they have significant ramifications on labour productivity and construction stakeholders should consider them when developing interventions to improve productivity. Notably, some of the factors identified during this study were also identified during pre-pandemic studies suggesting that the COVID-19 pandemic aggravated an existing problem in the sector.

4.4 Factor analysis

According to Yong and Pearce (2013), factor analysis is used to analyse the relationship between the original variables and group them into a limited, simple, and interpretable cluster of factors/components. Before conducting factor analysis, Bartlett's Test of Sphericity and the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy were computed to evaluate the appropriateness of the data for factor analysis. Table 4 shows that the KMO coefficient is 0.714, and Bartlett's Test of Sphericity is significant $p = 0.000$ (< 0.05) (Hair *et al.*, 2010), suggesting that the data is suitable for factor analysis.

Table 4: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.714
Bartlett's Test of Sphericity	Approx. Chi-Square	1387.866
	df	595
	Sig.	0.000

Principal component analysis and varimax rotation were applied to extract the COVID-19-related factors affecting construction labour productivity. Six (6) variables were dropped because their factor loadings were less than 0.50 (Hair et al., 2010). The variables dropped are disruptions of the global supply of materials, changes in regulations (e.g., the introduction of curfews), inadequate on-site H&S measures, inability to provide adequate access to sites, and inadequate site layout planning relative to COVID-19 requirements, and inadequate site welfare provisions.

Table 5 shows that nine (9) constructs/components/factors were extracted. The factors with Eigenvalues greater than 1, explained 76.0% of the total variance.

Table 5: Results of factor analysis

Factor	**Component**								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Factor 1: Poor project planning and management									
Poor communication	0.834								
Poor coordination of project team and activities	0.818								
Supervisory incompetence in COVID-19 protocols	0.816								
Poor project management practice	0.805								

Inadequate materials procurement planning	0.670								
Reduced number of on-site workers	0.576								
Inadequate H&S provisions	0.506								
Factor 2: Permits and inspection delays									
Delays in inspections and certification		0.763							
Delays in issuing permits		0.733							
Restrictive working conditions		0.636							
Inadequacies of public transport systems		0.573							
Factor 3: Cash flow and payment challenges									
Low remuneration			0.771						
Late payment of salaries and wages			0.765						
The poor motivation of workers			0.696						
Factor 4: Compliance with COVID-19 protocols									
Complying with COVID-19 protocols				0.698					
Worker absenteeism				0.673					
Inadequate use of plant and equipment				0.559					
Disruptions of the global supply of equipment				0.510					
Factor 5: Project disruptions									
Temporary project suspension					0.837				
Work stoppages/disruptions					0.879				
Factor 6: Lack of human resources capacity building									
Inadequate training in COVID-19 protocols						0.810			
Labour inefficiency						0.715			
Factor 7: Material supply disruptions									
Shortage of material supply in the domestic market							0.876		
Delays in the delivery of materials							0.827		
Factor 8: Labour supply disruptions									
Travel restrictions limiting personnel availability								0.646	
Reduced working hours								0.546	
Labour shortages								0.599	
Factor 9: Design changes and poor transfer of information									
COVID-19-induced design changes									0.720
Poor transfer of design information									0.569
Inadequate adoption and use of technology									0.507
Eigenvalues	12.3	2.8	2.3	1.9	1.9	1.7	1.4	1.3	1.2
Variance	35.1	8.0	6.7	5.3	5.3	4.7	4.0	3.6	3.3
Cumulative Variance	35.1	43.1	49.8	55.1	60.4	65.1	69.1	72.7	76.0

The extracted factors were named based on the composition of the variables that correlate highly with that factor.

Factor 1: Poor project planning and management

The 1st factor was named *'poor project planning and management* and explained 35.1% of the total variance. Seven variables loaded to this factor: poor communication, poor coordination

of project team and activities, supervisory incompetence in COVID-19 protocols, poor project management practice, inadequate materials procurement planning, reduced availability of on-site workers due, and inadequate H&S provisions. The COVID-19 pandemic and response efforts put to the test project managers' competencies regarding the ability to adapt and respond to situations effectively. The transition to virtual project leadership and management had several ramifications regarding efficient planning, effective management of the project teams from a much greater distance than usual, and planning to ensure resources are available on-site as and when needed. COVID-19 response efforts such as work-from-home (WFH) arrangements heightened the need for effective communication, new methods of supervision and coordination of teams (at work, home and on-site) and planning regarding procurement to ensure uninterrupted production because of changes in work arrangements. With the imminent risk of COVID-19 infection, inadequate H&S provisions affect workers' ability to work effectively on-site. The research findings are consistent with Rubin (2020) that poor and inefficient planning worsened productivity challenges in the construction sector during the pandemic. The results reaffirm the observations by Jallow et al. (2020) that the COVID-19 pandemic and response efforts make managing projects difficult as staff work from home.

Factor 2: Delays in inspection and issuing of permits

The 2nd factor was named *'delays in inspection and issuing of permits'* and explained 8.0% of the total variance. Four variables loaded to this factor: delays in inspection and certification of works, delays in issuing permits, restrictive working conditions, and inadequacies of public transport systems to timely and safely get workers to construction sites. During the COVID-19 Alert Levels 4 and 5, most local authorities' offices were either closed or operated with a skeleton staff, adversely affecting the turnaround time regarding project inspections, work certification, and permit issuing. The results are consistent with broader literature. For example, in the USA, Alsharef *et al.* (2021) report that delays in inspection and issuing permits during the COVID-19 pandemic contributed to a fall in productivity.

Factor 3: Cash flow and payment challenges

The 3rd factor was named *'cash flow and payment challenges'*, and explained 6.7% of the total variance. The three variables loading to this factor are low remuneration, late payment of salaries and wages, and poor motivation of workers. The COVID-19 pandemic aggravated the cash flow challenges for contractors, resulting in delayed payment of salaries and low salaries, consequently reducing worker motivation. This finding is corroborated by previous studies, which show that the pandemic significantly affected the psychology and motivation of construction workers (Nguyen *et al.*, 2021), consequently affecting labour productivity. However, as highlighted by Kapsos (2021), labour productivity growth is generally associated with higher wages and better working conditions.

Factor 4: Compliance with COVID-19 H&S protocols

The 4th factor was named *'compliance with COVID-19 H&S protocols'* and explained 5.32% of the total variance. The four (4) variables that load to this factor are complying with COVID-19 mitigation measures, increased worker absenteeism (related to COVID-19), inadequate use of plant and equipment, and disruptions of the global supply of equipment. While the intervention to limit workers' exposure to the risk of infection is essential, measures such as social distancing requirements, temperature screening and restrictions on the number of workers required on site are perceived to adversely affect construction labour productivity (Agyekum et al., 2021; Alsharef et al., 2021; King et al., 2021; McLin et al., 2020; Rubin, 2020). A reduction in the number of site workers coupled with limited capital deepening adversely affects labour productivity. Access to machinery and tools is essential to increase labour productivity. Nonetheless, the results are inconsistent with Ohrnberger et al. (2021),

who report that compliance with COVID-19 regulations reduces the risk of sickness and morbidity among workers and cumulatively increases productivity. This factor highlights the importance of balancing production and H&S on construction projects and the need for enhanced capital deepening.

Factor 5: Disruption of project activities

The 5th factor explained 5.28% of the total variance and was named *'disruption of project activities'*. The two variables that are loaded to this factor are temporary project suspension and work stoppages/disruptions. The factor highlights that the COVID-19 pandemic and response efforts affected labour productivity through work stoppages, project suspensions, and labour travel restrictions. For example, during lockdown Alert Levels 4 and 5, non-essential construction was suspended/stopped, and workers were not actively engaged in construction works. This was confirmed during another study in Zimbabwe, where Chigara and Moyo (2021b) reported that COVID-19 contributed to suspensions and stoppages of construction projects considered non-essential.

Factor 6: Lack of human resources capacity building

The 6th factor was named *'lack of human resources capacity building'* and explained 4.73% of the total variance. The two variables that loaded to this factor are inadequate training in COVID-19 protocols and labour inefficiency. The COVID-19 pandemic introduced radical shifts in work organization, which calls for training and retraining of workers to adapt and work effectively in the new environment. However, lack of training meant that workers were not empowered to recognize and avoid work-related hazards and work safely and efficiently, conforming to the pandemic protocols. The results reaffirm the findings of Quezon and Ibanez (2021) that workers' lack of training significantly contributed to low labour productivity in the Philippines during the COVID-19 pandemic. Furthermore, the results reiterate the importance of project-based training to empower workers to work safely and productively during and after the pandemic. Training workers to work safely and productively is essential to increase productivity.

Factor 7: Material supply disruptions

The 7th factor was named *'material supply disruptions'* and explained 3.97% of the total variance. Two variables loaded to this factor, namely, shortage of material in the domestic market and delays in the delivery of materials on site. The supply of materials for a construction project is vital to reduce idle time among workers. However, pandemic response interventions such as national lockdowns affected the production of materials and contributed to delays in the supply of materials to construction sites. Glitches in global supply chains aggravated this problem due to a global lockdown and reduced production capacity. This factor confirms extant literature regarding how material supply challenges affected labour productivity during the pandemic. Previous studies show that a reduction in labour productivity during the pandemic was associated with material supply disruption (Rubin, 2020), late deliveries of materials, and shortage of materials (Alsharef *et al.*, 2021; Construction Manager, 2020; King *et al.*, 2021).

Factor 8: Labour supply disruptions

The 8th factor was named '*labour supply disruptions*' and explained 3.60% of the total variance. Three variables loaded to this factor, namely travel restrictions limiting personnel availability, reduced working hours, and labour shortages. The COVID-19-related restrictions on the intra-region movement of workers and quarantines affected the ability of workers to travel to construction sites, thereby affecting the availability of critical/skilled labour on site. COVID-19 infections amplified the situation among construction workers, which affected their presence on site. In addition to the limited number of workers permitted

on site in line with COVID-19 social distancing requirements, construction labour productivity was affected by the reduction of working hours. During past studies, labour disruptions (Rubin, 2020) and labour shortages (King et al., 2021) were identified as factors contributing to a reduction in productivity in UK and Malaysia, respectively. Borland and Charlton (2020) report a dramatic fall in monthly hours worked from March to June 2020. The COVID-19 pandemic exacerbated labour supply challenges in the construction sector and heightened the call for workforce planning to ensure the successful delivery of construction projects.

Factor 9: Design change and poor transfer of information

The 9th factor was named '*design change and poor transfer of information'* and explained 3.29% of the total variance. Three variables loaded to this factor: COVID-19-induced design changes, poor transfer of design information, and inadequate technology adoption and use. The changes in design affect labour productivity through disruptions of workflow and changes in manpower levels in response to the changes. Remote working affected the flow of design change information, with a concomitant effect on on-site activities. The introduction of new work arrangements, such as work from home, highlights the need to embrace various forms of technologies to ensure the real-time transfer of design information from any location. However, the inadequate use of technology to disseminate information during the pandemic was a challenge to construction labour productivity. The results corroborate past studies where poor transfer of design information while remote working was reported to hinder labour productivity in the UK (Rubin, 2020) and Malaysia (King et al., 2021). In another study, Pamidimukkala and Kermanshachi (2021) concluded that workers working from home faced significant challenges due to employers failing to provide them with adequate access to digital infrastructure, resulting in inefficiency and failure to meet project deadlines.

5. CONCLUSIONS AND RECOMMENDATIONS

The study investigated the COVID-19-related factors affecting construction labour productivity based on perceptions of construction professionals in Zimbabwe. The top five factors are disruptions of the global supply of materials, shortage of material supply on the domestic market, inadequacies of public transport systems to timely get workers to construction sites, travel restrictions limiting personnel availability, and delays in the delivery of materials on site. Exploratory factor analysis revealed nine (9) significant factors affecting construction labour productivity, namely poor project planning and management, delays in inspection and issuing of permits, cash flow and payment challenges, compliance with COVID-19 H&S protocols, disruption of project activities, lack of human resources capacity building, material supply disruptions, labour supply disruptions, and design change and poor transfer of design information. Given that some factors in this study resonate with those identified during pre-pandemic studies, the results suggest that the factors affecting labour productivity are perennial in construction, hence the need to address them. Furthermore, the results suggest that the COVID-19 pandemic aggravated a systemic problem in the construction industry, thereby highlighting the need for a holistic approach to addressing the productivity challenge in construction.

The results have some important implications for policy and practice. First, the results highlight the importance of capacity building for local building material manufacturing firms to ensure self-reliance regarding the supply of construction materials. Second, poor project planning and management and deficiency in capacity call for collaboration between higher education institutions and industry to develop tailored training programmes to enhance project management skills for project and construction managers and capacitate workers' ability to recognize and respond to hazards while not compromising productivity. However,

the main limitation of the study arises from its failure to capture the perspectives of other important stakeholders, such as workers and clients. Future studies should seek to capture the views of these stakeholders to ensure a holistic view of the phenomenon under investigation.

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