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Assessment of measures instituted to curb the spread of COVID-19 on construction site

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ABSTRACT

COVID-19 pandemic has become a global health issue that is ravaging every aspect of human life. Various countries, thus, institute many measures to prevent the spread of the disease among the citizenry. This article investigates measures that are put in place at construction project sites to curb the spread of COVID-19 among construction site workers. An open-ended questionnaire was used as an instrument to collect qualitative data from construction companies. A purposive sampling method was used to distribute the interview questions. The collected data were analyzed with content analysis. The findings show that most construction companies have instituted prescribed and appropriate measures to curb the spread of COVID-19 on-site. Moreover, some construction companies had implemented extra measures and developed new protocols to help mitigate the spread of COVID-19 on-site. However, few construction companies were lacking in the provision of some of the recommended measures. The study identified three categories of measures (i.e. screening, site access and handling of material and equipment deliveries on-site) where improvement is required. Construction companies could use the recommendations provided to improve upon the approach adopted to curb the spread of COVID-19 on-site. The study could also inform policymakers on COVID-19 measures that are unsatisfactorily implemented on site for which more attention and oversight is required. Research on construction site health and safety measures during this COVID-19 season are still being developed. Thus, this article contributes to advancing the body of knowledge in this area of study. Data were collected from grades 6 to 9 construction firms; therefore, the research findings may not be applied to smaller construction firms. A study that focuses on lower grades is recommended.

KEYWORDS

Construction site; COVID-19; health; measures; safety; workers

Introduction

The coronavirus, COVID-19, pandemic has caused and is still causing havoc around the world. This global pandemic has had a catastrophic effect on both human lives and many countries' economies across the world (Harinarain 2020). All sectors of the economy, including the construction sector, which significantly contribute to employment and a country's Gross Domestic Product (GDP), have been severely affected by COVID-19. It is no secret that construction is one of the sectors where health and safety is a concern. Several studies highlight the inherent risk on construction sites (Hinze and Giang 2008; Pinto et al. 2011; Abrey and Smallwood 2014; Legg et al. 2015; Okoro et al. 2016; Maiti and Choi 2019). The COVID-19 pandemic aggravates construction site worker's exposure to risk and danger. The South African government has developed five levels of lockdown. Under alert level 3, construction activities are allowed; as such, construction sites are now opened for production. Although the World Health Organization (WHO) and the Government of South Africa have provided guidelines and measures to govern how employers operate, the guidelines and measures are not case-specific. Moreover, the measures that construction companies have put in place on-site to protect workers from COVID-19 are indeterminate. In fact, a study conducted by Małecka et al. (2020) revealed that authorities' recommendations are not fully implemented. Therefore, a study that determines the measures construction companies have put in place on-site to protect workers from COVID-19 is justifiable. In view of this, this study will address the question: 'What measures have been instituted to curb the exposure of construction site workers to Covid19?'

Literature review

Overview of COVID-19

The name COVID-19 – 'co for 'corona', 'vi' for 'virus', 'd' for 'disease' and '19' for the year the outbreak was first identified – was officially coined on 11 February 2020. The disease was first reported in Wuhan, a city in China. COVID-19 was declared as a Public Health Emergency of International Concern on 30 January 2020 by the World Health Organization (WHO) and subsequently as a pandemic by the same organization on 11 March 2020 (WHO 2020a).

COVID-19 is an infectious disease caused by severe acute respiratory syndrome coronavirus 2 (SARSCoV-2) (Centres for Disease Control and Prevention (CDC) 2019; WHO 2019). According to the CDC (2019), the incubation period of COVID-19 is between 2 and 14 days, with symptoms showing at an average of 5 days. The virus can spread through respiratory droplets produced when an infected person sneezes and coughs or by

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touching a surface or object that has the virus on it and then touching one's mouth, nose or eyes (CDC 2019; WHO 2020b).

Symptoms associated with the disease, i.e. if a person test positive, are the common cold, fever, cough, shortness of breath (for mild cases); or pneumonia, acute respiratory distress syndrome causing respiratory failure, septic shock, kidney failure or multiorgan failure (for severe cases) (CDC 2020; WHO 2020b). Some people show little or no symptoms at all (asymptomatic). Effective means of reducing the chances of infection include social distancing, the use of masks, frequent and thorough hand washing, avoiding touching eyes, nose and mouth, avoidance of public activities/mass gatherings, following good respiratory hygiene (WHO 2019).

Globally, as of 2:16 pm CEST, 18 August 2020, there were 21,756,357 confirmed positive cases and 771,635 deaths of COVID-19. Africa had 960,055 positive cases and 18,922 deaths, and South Africa had 589,886 cases and 11,982 deaths (WHO 2020c). More than 50% of the cases in Africa were recorded in South Africa. Although measures have been put in place, the rate of infection and spread continues to rise.

Construction site and COVID-19 measures

The construction sector contributes significantly to the economic development of any country. Conversely, the sector also contributes greatly to health and safety hazards. For example, a study conducted by Okorie and Musonda (2020) revealed a lack of management commitment to site health and safety issues. Maiti and Choi (2019) believe that many injuries and deaths occur on the construction site because safety issues are overlooked. Due to the COVID-19 virus, extra measures are required to ensure workers' safety in all industries, including the construction sector. Some of the important measures required to curb COVID-19 spread are hygiene, sanitation, physical distancing policies, provision of personal protection equipment and screening (Lemke et al. 2020; WHO 2020d). In South Africa, the Government Gazette No. 43400 (2020) provides comprehensive information on COVID-19 direction on health and safety in the workplace. The gazette focused on four key aspects: plan for re-opening workplaces, administrative measures, social distancing measures and health and safety measures. The four aspects are briefly discussed below.

With regards to the plan for re-opening workplaces, the Government Gazette No. 43400 (2020) indicates that the employer is required to undertake a risk assessment and develop a plan based on the risk assessment conducted. The risk assessment helps to determine measures to be instituted on-site to mitigate the spread of the virus. Planning and safety review should be accorded high priority (Maiti and Choi 2019).

Risk assessment is a core aspect of administrative measures. Developing and revising policies and procedures are also part of administrative measures (Rosemberg 2020). Additionally, administrative measures include instituting measures to minimize the number of workers at the workplace at any given time; and raising awareness (Government Gazette No. 43400, 2020). 'Knowledge is power'; therefore, employers must empower employees by providing them with adequate and relevant information about COVID-19. In fact, the Government Gazette No. 43400 (2020:14) stated, *every employer must ensure that workers are informed, trained, instructed and supervised*…. Similarly, Umeokafor et al. (2020) identified education and sensitization as one credible means of improving safety regulation. This is very important because COVID-19 is still new, and there is less understanding and misconception about it.

For Social distancing measures, the Government Gazette No. 43400 (2020) states that the employer is responsible for arranging the workplace to ensure minimal contact between workers. WHO (2020d) revealed that maintaining social or physical distance reduces the risk of breathing in the COVID-19 virus droplets (i.e. small liquid droplets from the nose or mouth) when an infected person coughs, sneezes or speaks. Where it is impractical to arrange the workplace to ensure social distancing (e.g. 1.5 or 2 m), Government Gazette No. 43400 (2020) advocates for arranging physical barriers and, where necessary supplying appropriate Personal protective equipments (PPEs) to workers based on the risk assessment of the workplace. Companies are expected to implement and supervise social distancing measures in all areas of the workplace, control queues, e.g. at the canteen, and where necessary, dividing the workforce into groups or staggering break time to avoid concentration (Government Gazette No. 43400, 2020).

The main health and safety measures identified by the Government Gazette No. 43400 (2020) include symptom screening, sanitization (hygiene), ventilation and PPE. Regarding screening, Government Gazette No. 43400 (2020) stated that the employer is required to conduct symptom screening of all workers and determine if any of the workers shows any of the symptoms associated with COVID-19; encourage workers to report symptoms; ensure isolation of workers diagnosed with COVID 19, and avoid discriminating against employees who contract the virus.

Good hygiene practice and sanitization are important preventative measures against the COVID-19 virus. WHO (2020d) revealed that a simple precaution such as regular and thorough washing of hands with soap and water or the use of an alcohol-based hand rub or sanitizer kills COVID-19 viruses that may be on the hands. According to Government Gazette No. 43400 (2020), it is the responsibility of the employer to, free of charge, provides sufficient quantities of hand sanitizers for workers and at the entrance, and where applicable, provide enough hand-sanitizer at that worker's workstation for both the worker and those that he/she will interact with; disinfect the areas, equipment and work surfaces; disable biometric systems or make them COVID-19-proof if need be; and provide adequate facilities, soap and clean water for the washing of hands.

Employers are responsible for providing appropriate PPE for their employees and ensuring that employees wear them (Government Gazette No. 43400, 2020). The basic COVID-19 PPE is the mask. The importance of mask-wearing cannot be ignored. WHO (2020d) explained that people are protected from COVID-19 infection if an infected person coughs, sneezes or talks while wearing a mask. This is because the mask prevents the droplets generated when the infected person coughs, sneezes or talks from reaching the face of others nearby and on the surrounding environment/surfaces. Other or special PPE may be required due to the nature of the job or the risk of the workplace. WHO (2020d) believes that the risk of exposure and vulnerability of the people, the setting/work environment and the feasibility of use should influence the selection of masks and PPE. Government Gazette No. 43400 (2020) encourages employers to regularly check the websites of the National Department of Health, National Institute of Communicable Diseases and the National Institute for Occupational Health and make provision for additional PPE required for the nature of the workplace.

Table 1. The demographic details of the participants.

Interviewee	Type of organization	CIDB grade	Gender	Position	Years of experience	Registration
Participant 1	Civil	6CE	Female	Junior Site Agent	2 years	N/A
Participant 2	Building and Construction	9GBPE	Male	Junior Site Agent	5 months	N/A
Participant 3	Construction Engineering	8GB	Male	Survey technician	7 years	SAGC
Participant 4	Building and Construction	7GB	Female	Quantity Surveyor	1 year	SACQSP
Participant 5	Building and Construction	8GB	Male	Junior Project Manager	2 years	N/A
Participant 6	Building and Construction	6GB	Male	Quantity Surveyor	6 years	SACQSP
Participant 7	Building and Construction	9GB	Male	Development Manager	14 years	SACPLAN
Participant 8	Civil engineering	9CE	Male	Quantity Surveyor	11 years	N/A
Participant 9	Building and Construction	8GB	Male	Quantity Surveyor	5 years	SACQSP
Participant 10	Building and Construction	7GB	Male	Quantity Surveyor	2 years	SACQSP
Participant 11	Building and Construction	8GB	Male	Construction manager	11 years	SACQSP
Participant 12	Building and Construction	8GBPE	Male	Director	20 years	N/A
Participant 13	Building and Construction	9GBPE	Male	HSE Coordinator	15 years	SACPCMP, ACHASM and SAIOSH
Participant 14	Civil Engineering & Construction	9CE	Male	Senior HSE Manager – Construction Platform	12 years	SACPCMP

Research methodology

A qualitative research approach was adopted for the study. Polit and Beck (2017) indicated that the qualitative research method enables researchers to gather in-depth opinions about a phenomenon under study from respondents. The qualitative research method also allows the researcher to explore individuals' experiences better to understand a complex phenomenon (Mohajan 2018). The specific qualitative approach adopted was phenomenology. A phenomenological approach allows respondents to provide their experiences, understanding and perceptions about a phenomenon from their own perspectives (Leedy and Ormrod 2015). The phenomenological approach was adopted for the study to allow the researcher to explore respondents' experiences with regards to COVID-19 safety measures instituted on-site from their own perspective.

The target population was medium to large construction companies; i.e. between grades 6 and 9 in the South Africa context. These are companies who could tender for projects of R 13,000,000 or more (CIDB 2015). This category of companies was selected because most had started operating at the time the data were collected (alert level 3) whereas very few of the smaller organizations were operating at that time. Moreover, these organizations would have performed risk assessments and instituted measures/guidelines before opening sites. Therefore, the questionnaire was sent to only grade 6 to 9 companies. Thus, purposive sampling was used to select respondents to partake in the study. Purposive sampling enables the researcher to identify willing and have the knowledge or experience to participate in a study (Blumberg et al. 2008). A total of 25 questionnaires were distributed; however, only 14 representing 56% were returned and consequently used for the analysis. Creswell (1998) revealed that Samples between 5 and 25 are generally considered adequate for a phenomenological study.

Data were collected by means of an open-ended questionnaire. Due to the COVID-19 regulations such as social distancing and traveling ban, imposed by the government, the open-ended questionnaires were self-administered to the participants. The open-ended questionnaires were, thus, emailed to the participants for them to fill in and email back. Questionnaires for qualitative study are generally open-ended and semi-structured (Leedy and Ormrod 2015). An open-ended questionnaire was used for this study to allow participants to express and clarify their opinion without any restrictions.

The questions were categorized into three parts. The first part dealt with the respondents' demographic information such as gender, current position in the organization, work experience and professional registration status (Table 1). The second part sort for information on the respondents' current projects (Table 2), whilst the third part required respondents to provide details of the COVID-19 safety measures (i.e. social distancing, housekeeping and hygiene (sanitization), screening, PPE, creating awareness, site access and handling of deliveries) instituted on site (Table 3).

Table 2. Respondents current projects.

Current project	Frequency	% of respondent
Construction of residential housing	7	50%
Renovation of hospital	2	14.2%
Construction of road	2	14.2%
Construction of hospital	1	7.2%
Construction of lecture hall	1	7.2%
Mall renovation of Mall	1	7.2%
Total	**14**	

The collected data were prepared, coded, structured and analyzed. Content analysis was used for the data analysis. The content analysis emphasizes on meanings instead of quantifiable incidences and it is suitable where the study has exhaustive information instead of categories (Schutt 2012). The process adopted was screening the responses for analysis; studying the responses received, coding the responses manually in an Excel spreadsheet, describing each interview response, grouping similar and interrelated themes; determining the responses' magnitude (Creswell 2014).

Findings

Profile of respondent

Table 1 presents an overview of the demographic details of the participants. It is evident that 78.6% of the participant organizations were Building and Construction firms, and 21.4% were Civil Engineering firms. Regarding CIDB designation, 2 were registered as grade 6GB/6CE, 2 as grade 7GB, 5 as grade 8GB/GBPE and 5 as grade 9GB/GBPE/CE. Thus, 10 (71.4%) of the participants were from either grade 8 or 9 companies.

It is also evident that most of the participants (85.7%) were male whilst 14.3% were female. A total of 64.3% were registered with a South African professional body. The majority were registered with SACQSP, which also supports the respondents' position – 35.7% were quantity surveyors, 14.3% were health and safety practitioners, 14.3% were construction/construction project managers, 14.3% were site agent and 21.4% occupied other

Table 3. COVI19 health and safety measures instituted on site.

Categories	Measures instituted
Social distancing	• Seats set to be 2 m apart
	• Markers placed on the floor.
	• Staggering work activities.
	• Conducting meetings virtually.
	• Quantity restrictions of transportation vehicles.
	• Provision of physical barriers *(e.g. Protective dividing screens)*
Housekeeping and hygiene (sanitization)	• Provision of wipes, alcohol-based sanitizers and hand rubs to workers free of charge
	• Hand washing facilities (soap dispenser, water, paper towel)
	• Hand sanitizing stations (e.g. elbow sanitizing units and sanitizing foot stands)
	• Increase the frequency of cleaning
	• Additional cleaners assigned
	• Employment of Permanent sanitizing personnel
	• Provision of no-touch refuse bins
	• Provision of additional toilets facilities
Screening	• Thermometer used to take the temperature on site.
	• Completion of a questionnaire
	• Provision of screening rooms
	• Provision of isolation area next to screening rooms
	• Provision of sanitizing both
PPE	• Face mask (washable)
	• *KN95/N95/FFP2 masks for high-risk areas and activities*
	• Face shield/Visor
	• Disposable gloves
	• Sanitizers
	• *Plastic aprons*
	• Disinfecting wipes
	• *Hazmat suits (for high risk individuals/vulnerable workers)*
	• Provision of a special PPE store
Creating awareness	• loud hailer to remind workers to wash their hands on an hourly basis
	• Covid-19 posters/signboards
	• Covid-19 induction
	• Regular toolbox talks awareness sessions
	• Discussions on basic Covid-19 hygiene principles
	• Training
	• Emails
	• Webinars
	• WhatsApp groups
	• The use of voice-over video in the language of choice
	• Emergency numbers on notice boards
Site access	• Visitor are allowed on site only by appointment
	• Daily site register is kept of all visitors
	• All visitors are screened
	• All visitors are sanitized
	• *Visitors induction covering COVID-19*
	• *No visitors are allowed without standard PPE and basic COVID PPE*
	• *Security guide all visitors to the designated parking area*
	• Provision of *access tag to visitors*
Handling of deliveries	• All deliveries follow the same screening procedure
	• All paperwork is placed in a quarantine box
	• Materials and equipment are disinfected before use where possible
	• Material and equipment are delivered to designated areas
	• Only one person handles delivery
	• Additional storeroom provided as a holding store
Compliance	• Watchers to police the site
	• Disciplinary procedure for not complying

positions. With respect to experience, it can be inferred that 42.9% of the respondents have been working in the construction industry for not less than 10 years, 21.4% for 5 years or more and 35.7% for less than 5 years. Thus, a total of 9 respondents representing 64.3% had more than 5 years of working experience. This implies that respondents had worth of experience in the industry. The organizations' designation and the high level of experience of participants helped gather valid and rich data.

Nature of current project

The participants were asked to provide a brief description of the overview of their current project. Table 2 presents projects and frequency. It can be inferred that the majority (50%) of the respondents are currently working on the construction of residential housing projects, followed by the construction of roads and renovation of hospitals.

COVID19 health and safety measures instituted on site

Participants were asked to indicate the specific measures instituted on site to curb the virus's spread. The basic COVID-19 measures such as social distancing, sanitization, screening, PPE, creating awareness, as well as, site access and handling of deliveries on site were used as the broad categories. Table 3 illustrates the specific measures organizations had implemented under each of the categories.

Discussion

Social distance

Social distancing is one of the effective but easiest ways of keeping safe during this time. All participants indicated that measures were put in place to adhere to the basic 1.5 m distancing on site. Moreover, participants revealed that social distancing was practiced everywhere on-site and off-site where necessary, e.g. during training, lunchtime, at the offices and on the bus. Few examples of the responses are provided.

> *All employees are seated a minimum of 2m away from each other* (P14). *… with 1.5m markers placed for…* (P2). *Transportation vehicles have quantity restrictions so that workers are seated 1m apart* (P5). *Social distancing is employed in all areas of operation… during entering and exiting site, meetings, training, creating different areas for and staggering start of work and lunchtimes, training sessions…* (P7).

It is encouraging that most of the companies arranged physical barriers, supplied PPE to workers and divided the workforce into groups or staggered work as indicated in the responses below.

> For example, P8 indicated that *Face shield are used where social distancing cannot be achieved.* Moreover, P14 stated, *Visors are compulsory for all security guards, screening personnel and employees required to be in close contact, less than 1.5m together for tasks which may require working in close proximity.* Examples of how work was staggered are, *The full-time workers come to work weekdays and the temporary personnel are requested to come in shifts….* (P3). *limited number of people allowed to work with rotation of teams in order to improve on social distancing* (P7). *Where applicable, specific activities are being staggered…* (P8). *Meetings are conducted virtually with the provision of videos and pictures for site progress for those who are not responsible for direct execution of the project* (P1). *Technical and progress meetings with professional team held using digital conferencing software e.g. Zoom etc* (P9).

It can be inferred that all companies maintained social distance quite well. Whereas most of the companies maintained 1.5 m, one company adopted 2 m. Social distancing is crucial because it helps to reduce the risk of breathing in the COVID-19 virus droplets when an infected person coughs, sneezes or speaks (WHO 2020d). It is also commendable that companies provided physical barriers and supplied PPE to workers where it was impractical to arrange the workplace to ensure 1.5 metres distance apart, as Government Gazette No. 43400 (2020) advocates. It is also impressive that some companies adopted digital conferencing software, e.g. Zoom, as a means of promoting social distancing. Małecka et al. (2020) believe that the introduction of team segregation can help to reduce the spread of the virus. The fact that all companies had measures in place to limit workers on-site and promote social distancing on-site is inspiring.

Housekeeping and hygiene (sanitization)

All participants indicated that measures required to promote good hygiene (sanitization) were provided on-site. However, P3 was not convinced of how his/her organization was handling the issue of sanitization.

> P1 stated, *Sanitation equipment required to mitigate the spread of the virus is provided on site.* However, P3 stated, *There is a sanitizer on site, however, it is only used when the personnel enter the site and during the day it will be business as usual.*

The participants listed several measures put in place to ensure good hygiene. For example, P12 stated that extra toilet facilities had been provided on-site. Also, some respondents revealed that in addition to the provision made for the individuals, the sites were provided with sanitization stations.

> For example, P1 stated, *Elbow sanitizing units as well as sanitizing foot stands have been placed all around site to allow workers to sanitize frequently.* P12 stated, *Hand washing facilities were introduced to site at strategic points, so all inhabitants are able to wash their hands prior and after breaks. Hand sanitizing stations have been placed all over site to encourage staff to sanitize at least every hour. These wash stations have soap dispenser and water, paper towels, and foot pedal hand sanitizer available* (13).

Some participants highlighted the frequency and areas of cleaning and sanitization. It is worth highlighting that some organizations had appointed specialists to do the site's cleaning and sanitization.

> For example, P2 revealed that, *…cleaning of air-conditioners was done once a week, cleaning of door handles and toilets constantly. Daily cleaning of common areas such as toilets, offices and eating areas; weekly sanitising fogging of entire site* (P14). P12 stated that *4 additional cleaners were assigned to clean ablutions, canteen areas and containers 4 times per day*

Despite companies' effort towards curbing the spread of the virus, P3 revealed that some employees did not comply with sanitization protocols. Compliance is a huge challenge during this time. Few organizations have put measures in place to deal with the challenge of non-compliance of workers. Whilst one company had adopted the approach of policing, few used awareness to promote compliance.

> P12 stated, *watchers have been employed to police the site, disciplinary procedure for not wearing masks, sanitizing and complying has been implemented where 3 offences earn a staff member immediate dismissal.* P2 stated, *All workers are informed to practice cough etiquette by coughing into the elbow and to keep distance from others to prevent the spread of particles.*

Government Gazette No. 43400, (2020) listed several measures required to promote good hygiene. It is revealing that participants mentioned all the measures and few extra (i.e. wipes, hand soap, sanitization both, alcohol-based sanitizers and hand rubs, disinfectants, disposable/paper towels, no-touch refuse bins and soap dispensers and elbow dispensers). Hygiene is regarded as one of the simple precautions that can help kill COVID-19 viruses on the hands (WHO 2020d). Therefore, it is commendable that all the companies provided sanitization pack for workers as well as sanitization stations on-site to promote good hygiene. The fact that specialists were appointed to handle cleaning and sanitization is encouraging and shows the effort some companies had made in the fight against the virus's spread. It is also laudable that companies had adopted different strategies to reduce the chances of non-compliance.

Screening

The COVID-19 pandemic has ushered in a new norm where screening has become mandatory for organizations, including construction firms. Government Gazette No. 43400 (2020) states that employers need to screen workers before they are granted access to the workplace. Although 12 of the participants indicated that their organizations had instituted a formal screening scheme, 2 participants stated the opposite.

> P3 stated, *unfortunately there are no measures in place for screening such as the infrared thermometer but the screening is done in an informal way where a person would be observed with naked eyes and they are requested to stay home should they display Covid19 symptoms for two consecutive days.*

It can be inferred from the responses below that the common approach to screening was the use of a questionnaire and thermometer to check the temperature of workers. Also, the

importance of record-keeping was highlighted. Examples of responses are provided.

> P4 stated, *Infrared thermometer is used daily to take temperature on site. A daily questionnaire is also administered to the site staff about Covid symptoms such as cough, sore throat, etc.* P7 also stated, *The screening involves one pager questionnaire looking at the COVID 19 symptoms and checking previous contact with positive people or any trip to outside the country. Also, the temperature readings which are recorded daily.*

> With regards to record keeping, P13 stated, *At the end of each working shift each employees' details are captured onto an electronic register in the event that we need to conduct a track and trace due to a confirmed case of Covid19. All results placed on register for record keeping purposes* (P14).

The fact that action was taking if a person exhibited COVID-19 symptoms during screening is also laudable. This was stressed by few respondents.

> *If temperature is above 38 degrees access is denied…. decide to go see a Doctor for medical assessment* (P3).

The responses further reveal that the frequency of screening varied; most companies had screening once daily whilst others had it more than once in a day. It is also positive that companies that had shuttles did screening before workers joined the shuttle and before entering the site.

> P4 stated, *Infrared thermometer is used daily, and questionnaire is also administered.* Similarly, P7 indicated that, *All the workers are being screened daily when they fill the attendance register.* On the other hand, P14 stated, *Daily temperature screening and ad hoc screening of random employees daily.*

> *Site personnel are screened before they get on the truck to travel to site, and once again when arriving on site, where they fill in a daily access sheet and are measured for temperature again* (P5).

The use of sanitizing both, separate screening rooms and isolation areas was highlighted by some participants, which is quite impressive.

> *An isolation area is provided next to the screening room … screening rooms are available where the appointed Compliance Officer conducts a COVID 19 questionnaire and gives an insight of the virus awareness* (P2).

> *A quarantine area and emergency procedure were provided in the event of an employee showing symptoms* (P12).

It is evident that 12 companies met the minimum screening requirements (Questionnaire and thermometer). It is very encouraging that some companies have instituted extra measures to mitigate the spread of the virus. For example, some companies did more than one screening in a day, which could help identify cases quicker and limit the virus's spread. Others have instituted an effective record-keeping system to facilitate contact tracing. Moreover, some made provision for sanitizing both separate screening rooms and isolation areas and further provided awareness during screening. Self-isolation (Ohia et al. 2020) helps to mitigate the spread of COVID-19. Although most companies have instituted good screening schemes to help mitigate the spread of COVID-19 on-site, it is surprising that two companies did not have a formal/basic screening scheme. This is frightening because South Africa currently has the highest cases in Africa.

Personal protective equipment

All participants indicated that COVID-19 related PPE was provided to the workers. Other respondents provided a list of the PPE that was provided. Moreover, some respondents (e.g. P2) revealed that these PPEs were supplied in addition to the other PPEs required on site.

> For example, P11 stated, *We have introduced face shield, disposable groves, face mask, sanitizers…* P6 also stated, *Disposable Protective masks 50 per box; Reusable Cloth Washable Protective Masks 100 per box; Disinfecting wipes in bucket * 500wipes - per 5litre; Disposable Latex Gloves in 100s; Reusable Face Shield Visor.* P2 also indicated *… has issued face shield and washable mask … as extra precaution as part of general site rules.*

It can be inferred from the responses that most companies provided PPE based on the risk assessment of workers and/or the job requirement as advocated by Government Gazette No. 43400 (2020) and WHO (2020d). Some companies distinguished between high-risk areas and vulnerable workers from the low-risk area and less vulnerable people. The vulnerable included those workers who are forced to contact staff on checking in, cleaners and workers more than 55-year old.

> For example, P2 stated, *The PPE is selected based on the hazards upon the worker.* P8 clarified that, *KN95 masks were given in high risk areas and FFP2 masks were given where, for example, cement is used, and normal cloth masks….* P14 revealed, *All screening officers at project gates are issued with special PPE – Surgical Masks (N95), Face Shield, Latex Gloves, Plastic aprons.* P9 also sated, *Hazmat suites (for high risk individuals) …* Additionally, P21 revealed that, *Protective suits have been assigned to vulnerable workers. This includes employees who have been tasked with signing in of staff and cleaners.*

Participants also highlighted that effort was not limited to just provision, but measures were put in place to ensure that the PPEs were monitored, maintained and replaced when necessary. Additionally, information and training on the use of PPEs were provided to workers. Examples of statements from respondents are provided below.

> P2 stated, *The PPE are regularly inspected, maintained, and replaced if needed* (P3). *…frequent replacement of masks…* (P1). *Trainings on PPE usage communicated to Site labour and PPE training records kept in files* (P2).

To deal with the challenge of non-compliance, one company instituted a system to police the use of PPEs on site.

> P12 revealed, *PPE watchers have been employed to police the site, ensuring that staff are maintaining social distancing is upheld. A disciplinary procedure for wearing masks, sanitizing and complying has been implemented where 3 offences earns a staff member immediate dismissal.*

Rosemberg (2020) Believes that there is a need to ensure adequate provision of PPE. Employers should ensure enough supply of personal protective equipment to minimize the risk of infection (Małecka et al. 2020). Thus, it is positive that the general responses suggest that COVID-19 PPEs are provided to site workers. Chandi et al. (2018) are of the opinion that improper use of PPE is a major risk on construction sites. Therefore, it is prudent that site workers were offered training on the usage of COVID-19 PPEs as highlighted by some respondents. People have different risk profiles, and jobs have varying degrees of risk, so it is very thoughtful that companies provided PPE based on the risk assessment of employees and the workplace. Government Gazette advocates providing PPE based on the risk assessment No. 43400 (2020). Construction sites are generally risky; therefore, the fact that compromises were not made in the provision of normal site PPEs is good. It is also inspiring that systems are in place to ensure that PPEs were always used, used correctly, maintained and replaced when necessary.

Awareness and information dissemination

Participants provided varying measures their companies had put in place on-site to inform and educate workers about COVID-19.

For example, P126 stated, *a loud hailer has been assigned to site and a reminder is announced for washing hands on an hourly basis*. P5 also sated, *2 x 7 (14) Covid-19 posters are situated on site to create awareness*. P13 revealed that, *Aside from the Covid 19 induction there are regular toolbox talk awareness sessions, various posters displayed at strategic points on site as well as ensuring basic hygiene principles are discussed and enforced*.

P2 provided a comprehensive detail, *Site Specific Induction revised under the Covid-19 Protocol. Trainings conducted prior site works for every individual on site. WhatsApp groups are being used as a platform to share views and new elements arising regarding the Virus. The site has triangular stands, change Room, boardroom and site offices has all the relevant safety and Covid-19 Awareness, Emergency contact list displayed*.

It can be inferred that most companies had revised their induction, toolbox talk and training sessions to accommodate COVID-19. Moreover, some companies had appointed a specialist to prepare the documents and had appointed COVID-19 compliance officers to educate workers.

For example, P2 revealed that *inductions have been revised under the Covid-19 Protocol*. P12 stated, *A Covid-19 induction pack was prepared for our company by an occupational health practitioner who is a medical doctor… Toolbox talks are conducted daily in small groups to the staff by an assigned COVID compliance officer*.

It is worth noting that some companies used videos with voice-over in different languages to make it easy for all site workers to better understand the content of COVID-19 information presented.

For example, P14 stated, *formally inducted by means of an animated video containing the relevant information on COVID-19 (What the virus is, symptoms, risk, control measures, reporting, etc.). The video has a voice-over in the language of choice (ex. Xhosa on one of our rural Eastern Cape projects)*.

Although 13 participants had no issue with how their companies created awareness, participant 3 had a contrary view.

I personally believe the training we received is not sufficient as it was only conducted for a couple of hours and some information could have been omitted by the director (P3).

The Government Gazette No. 43400 (2020) stated that the employer is responsible for creating awareness of COVID-19 on site. It is evident that all companies provided awareness on COVID-19 on site. The responses also show that several measures were used to inform and create awareness about COVID-19. The use of specialists in preparing training materials and compliance officers' appointment to take full responsibility for COVID-19 training is commendable. Additionally, voice-over videos are highly commendable because it helps convey information to workers in languages of their choice. Although one respondent felt that the company was not doing well with COVID-19 training or information sharing, most companies had instituted good measures on-site to create awareness and inform workers about COVID-19. Education and awareness help to improve safety regulation (Umeokafor et al. 2020).

Site access

All participants, except P3, indicated that access to the site was restricted. Moreover, most participants indicated that visitors went through the screening, just like employees, before access to the site was granted.

For example, P2 indicated, *No person is authorized to enter site unless an appointment has been made with the site agents*. P4 stated, *daily site register is kept of all visitors, as well as warding off the site so no one has access without being screened first*. P5 revealed that *Visitors report to the office where they fill in a daily access sheet and are screened. All visitors are screened and sanitised* (P9).

It is worth noting that most of the organizations only granted access after visitors completed a register, went through screening process and complied with general requirements for site visitors, i.e. visitors' induction, wearing COVID 19 PPE and wearing of standard PEE.

For example, P2 stated *… the visitors will proceed to the Safety Officer for a Visitors Induction*. Similarly, P12 stated, *No visitors are allowed without standard PPE and basic COVID PPE*.

Few participants highlighted that their companies had instituted good record-keeping systems, monitoring and control of visitors and parking.

For example, P14 stated, *Visitors notify person they are going to meet with in advance, this person will then notify management, who needs to approve formally, and make arrangements with security (Date, Time, Visitor Name, ID Number) regarding the visit*. P2 indicated, *The security officer on duty will guide all visitors to the designated parking area*. P13 stated, *The only persons permitted to drive up into the building is the vehicle driver and a single passenger… access tag is specific for each day and date*.

One participant revealed a creative system the company has adopted to limit access to the site.

The Contractor permit only essential workers to spend time on site, Staggered meeting/eating times, use of Zoom, Skype, teams for meetings where necessary (Respondent 10).

It is evident that some companies have established a good record-keeping system and effective monitoring and control. These measures are crucial for contact tracing purposes; thus, it is commendable that companies have put such systems on-site. Where possible, some companies limited access to the site by introducing Skype and Zoom for meetings. The general responses suggest that most South African construction firms are managing site access quite well. However, it is alarming that one company did not have a simple system (security personnel) to control site access.

Handling deliveries of materials and equipment

With specific reference to material and equipment delivery and handling on-site, whilst 12 companies had revised their system to incorporate COVID-19 protocols, 2 companies were yet to revise their systems.

For example, P2 stated, *All deliveries are required to follow the same screening procedure. All paperwork is placed in a quarantine box for 10 days before it is opened*. P7 wrote, *Materials and equipment delivered on site are being disinfected before use where possible*. P8 detailed that, *Material and equipment are only delivered to designated areas on site where screening is done*. Others stated, *handled by only one person* (P11), *We have included an additional storeroom as a holding store* (P12). *…. segregated facilities for safe keeping* (R14). However, R5 stated, *Materials such as bricks and cement cannot be treated. This is not controllable on site as too many items pass through each day*.

It is evident that most companies have instituted effective systems and appointed specific person(s) to handle deliveries of documents, materials and equipment on-site to ensure that deliveries were sanitized, packed and stored separately in special storerooms. WHO (2020d) revealed that the COVID-19 virus could remain on substances/surfaces for days. Therefore, implementing a system for handling material and equipment on-site is critical due to the risk associated with material/equipment handling.

Table 4. Summary of discussion.

Measures	Key summary
Creating awareness	All companies had instituted measures on-site to create awareness and inform workers about COVID-19. However, it is quite concerning that one participant was not convinced with how his/her company handled COVID-19 training or information sharing.
Social distancing	All companies maintained social distance quite well. The fact that all organizations had measures in place to promote social distancing on-site is inspiring. It is also impressive that some organizations adopted digital conferencing software to promote social distancing.
Hygiene (sanitization)	Hygiene is regarded as one of the simple precautions that can help kill COVID-19 viruses on the hands. Therefore, it is laudable that all the companies provided sanitization pack for workers as well as sanitization stations on-site to promote good hygiene. It is also commendable that companies had adopted different strategies to reduce the chances of non-compliance.
PPE	All companies provided basic COVID-19 PPEs to site workers. Moreover, it is commendable that companies provided PPE's based on the risk assessment of employees and workplace and had instituted systems to ensure that PPEs were always used, used correctly and maintained and replaced when necessary.
Screening	Although most companies have instituted good screening schemes, it is surprising and worrying that 2 companies did not have a formal screening scheme. It is encouraging that some companies made provision for sanitizing both separate screening rooms and isolation areas and further provided awareness during screening.
Site access	Thirteen companies had implemented good measures to managing site access quite well. However, it is disappointing that one company did not have a simple system to control site access.
Handling of deliveries	Twelve companies had instituted effective systems and appointed specific persons to handle deliveries. However, it is shocking that as many as 2 companies had not implemented COVID-19 material and equipment handling measures on-site.
Compliance	Two main approaches used to ensure compliance were punishing non-compliance and promoting awareness to ensure compliance.

Summary of discussion

The general responses indicate that most of the WHO's (2020d) measures and Government Gazette No. 43400 (2020) were implemented on site. Although the provision was at varying levels, the responses suppose that most construction companies have instituted adequate measures to help mitigate the spread of COVID-19 on site (see Table 4).

Conclusion

This study determined measures that South African construction companies have instituted to curb the exposure of construction site workers to COVID-19. COVID-19 has ushered in a new norm where social distancing, good hygiene, sanitization, screening and the use of appropriate PPE have become important. It is evident that most construction companies have instituted prescribed and appropriate measures to curb the virus's spread on site. Measures including social distancing, sanitization, provision of PPEs and dissemination of information (creating awareness) were well-implemented by all participating construction firms. However, few construction firms were lacking in the provision of some of the basic recommended measures. The study identified three areas where improvement is required, i.e. screening, site access and handling of material and equipment deliveries on-site. This study contributes to the body of knowledge on COVID-19 construction site measures.

Based on the preceding, it is recommended that all construction firms – small, medium and large – ensure effective access control and institute a system to manage the deliveries of materials and equipment on site. Moreover, all construction firms are urged to ensure appropriate screening of all workers and visitors. This is significant because screening is the only means of identifying the symptoms of COVID-19. In this way, persons who may exhibit symptoms of the virus could be identified and prevented from entering the site, thereby limiting the risk of a possible spread of the virus. Furthermore, construction firms are commended for catering to COVID-19 safety measures when tendering for projects. This will help them get enough resources to provide the site workers' required safety gadgets to prevent the virus's spread. For the regulatory bodies, frequent inspection of construction sites is recommended to ensure that companies comply with the COVID-19 regulations and protocols. In that way, the government would be able to ensure good oversight in the fight against the spread of the virus on construction sites

The data were collected from only large construction companies. Hence, the findings do not represent lower grades. The study recommends further studies be conducted using lower grades. Moreover, further study to determine why some organizations have lapses in implementing the basic COVID-19 measures on site is recommended.

Disclosure statement

No potential conflict of interest was reported by the authors.

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