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Beyond the Lockdowns: Investigating the Impact of Covid on Technology Adoption in the Construction Industry

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ABSTRACT

The coronavirus pandemic significantly impacted every aspect of human life and endeavour. It caused deep disruptions in every sector due to the various measures enacted to curb its spread. One of the many measures was the lockdown and work-from-home measures. These measures, among other disruptions, informed the adoption of various technologies. Through a quantitative approach, this study studied the impacts of the Covid 19 pandemic by identifying the various technologies and innovations adopted in the construction industry due to the coronavirus pandemic. A well-structured questionnaire was randomly distributed to construction professionals in South Africa. The results reveal that the adopted technologies due to the COVID-19 impacts can be classified into "construction technologies" and "smart building technologies". Also, the study ranked the various technologies adopted based on their significance.

Keywords: Black swan event, Construction digitisation, Technology adoption

INTRODUCTION

The novel COVID-19 pandemic created severe health challenges and impacted the global community deeply. Every facet of the human population and sectors of the economy felt the impacts of the pandemic. Han et al. (2020) in their study, focused on nine countries and regions which were analysed to provide a cross-country perspective. The study discussed the impact of the pandemic on the human populace using different countries and regions; it also identified the various mitigation measures being adopted in the countries adopted for the study. It was observed that although the pandemic is global and similar measures were being undertaken, however, the approach to reducing the impact is context-dependent. Similarly, Jamaludin et al. (2020) presented various strategies, measures and impacts of the Covid 19 on the different aspects of human lives

The construction industry was severely impacted by the pandemic, and due to this impact, various research has been conducted on the construction sector. Assaad & El-adaway (2021) revealed that the pandemic revealed the weakness in the integrated global supply chain. The study also proposed several areas that require research in the construction industry to manage

the pandemic impact better and improve the construction industry outlook. In the United States, it was observed that the construction industry suffered from shortage of material and delays in supply, reduced efficiency and productivity, expected increase in disputes, suspension of ongoing projects, and price escalation, among others (Alsharef et al., 2021). However, the study also identified that despite the challenges, the pandemic also presented some opportunities for the construction industry, this includes lower interest rates and the ability to recruit skilled workers, among others. The impacts identified are similar to that identified by Gamil & Alhagar (2020); these include a shortage of workers, escalated price of materials, shortage of materials and supply chain challenges.

In the Philippines, it was observed that various firms responded to the pandemic differently. Based on the company size, it was observed that smaller firms adapted faster and better when compared to large firms with more manpower. According to Cabanesas et al. (2021), although many firms in construction complied with the effect of the pandemic in terms of health and safety requirements, total compliance was not achieved. Compliance was achieved more with smaller firms; however supply chain was discovered to be majorly affected generally.

Similarly, the impact of the pandemic was observed on the field and office workforce. It was found that an unsafe working environment, limited access to tools, social isolation, personal and family related challenges were some of the challenges faced during the pandemic (Pamidimukkala & Kermanshachi, 2021). In a similar vein, Araya (2021) studied the pandemic as it affects construction workers. The study posits a reduction of workers on sites to between 30% to 90% due to the impacts of the pandemic. Most design professionals could work from home during the pandemic, and some experienced increased productivity during this period (Bsisu, 2020). However, working from home could not apply to site workers and other professionals who require on-site physical presence to execute their obligations.

Despite many studies viewing the pandemic impact mostly as negative, Esa et al. (2020) viewed it from both positive and negative consequences. This was based on a COVID-inspired measure implemented by the Malaysian government. The study opined that safety prevention and regulatory compliance were a positive offshoot of the pandemic on construction sites. This was attributed to the stricter and more frequent implementation of safety measures to reduce covid impact. On the other hand, the study identified the negative impacts on time, cost, human resource and resource availability towards achieving project success.

On the contractual aspect and its attendant issues due to the pandemic, the pandemic brought about the introduction and necessity for a review and update of the force majeure clause in the construction industry (Hansen, 2020). It thus introduced a new perspective to all existing processes and regulations in the construction industry. Salami et al. (2021) opine that the increase in contractual disputes due to the disruptions caused by the pandemic can be mitigated through conflict avoidance measures. The study

lists maintaining strong relationships and reevaluating contractual terms as some of the significant measures taken by construction organisations in dealing with the contractual consequences of the pandemic. Similarly, Adekunle et al. (2023) critically analysed the construction industry in light of the coronavirus and provided some insights on the lifeline available to the industry.

Although the industry has been severely impacted like other sectors adversely, it has been identified to be a critical contributor to the recovery of the economy. This can be studied from two perspectives: the recovery of the economy through the construction industry and the construction sector's recovery. Firstly, the construction industry is observed can create social value, social and economic outcomes for workers through increased infrastructural spending to achieve sustainable recovery from COVID-19 impacts (Denny-Smith et al., 2021). Regarding the recovery of the construction industry from the pandemic, technological adoption has been observed to be critical (Ebekozien & Aigbavboa, 2021). On the recovery of the sector and the role of the adoption of technology, Pamidimukkala & Kermanshachi (2021) and Majumder & Biswas (2021) opined that the use of technology should be encouraged in the construction industry and as a strategy to overcome some of the challenges introduced by the pandemic. This is supported by the benefits inherent in the adoption of the technologies in the construction industry, and the transformation observed, among others (Adekunle, Aigbavboa et al., 2021; Ejohwomu et al., 2021).

Unfortunately, the construction industry has been observed to be a slow adopter of technology. Given the measures adopted during the pandemic and the impacts of the same, on the construction industry, this study investigated the impacts of the pandemic on technology adoption in the construction industry. It identified the various technologies that were covid inspired or motivated in terms of adoption through the impacts. Therefore, the study aim to identify the emerging technologies that were adopted especially in the developing country context.

RESEARCH METHODOLOGY

On the one hand, the construction industry is a slow adopter of technology and, on the other hand, heavily impacted especially in developing countries, by the pandemic. This study identified the COVID-19 inspired technologies adopted in the South African construction industry; a quantitative approach was adopted whereby the interaction of the variables was tested and evaluated. The quantitative approach has been adopted to achieve objective evaluation and investigation of various challenges in the construction industry (Adekunle et al., 2022; Aliu et al., 2022; Ikuabe et al., 2022; Oladiran & Onatayo, 2019). A structured questionnaire was administered to construction industry professionals in the South African construction industry. Random sampling was used during the data collection granting all professionals equal opportunities of partaking in the study. A reliability test of the instrument through Cronbach's Alpha reveals a value of 0.968. This is considered an acceptable value.

FINDINGS

BACKGROUND INFORMATION OF RESPONDENTS

The respondents for this study possess various educational qualifications. 41.90 % are bachelors degree holders, 23% are professionals with diplomas, while 5.40% are professionals with a masters degree, and 29.70% are professionals with qualifications other than the ones listed but are skilled and experienced. Professionals for the study included quantity surveyors (20.30%), electrical engineers (4.10%), construction managers (2.7%), construction health and safety were 2.70%, mechanical engineer was 1.40%, and Architects were 1.40%. Other professionals constitute 67.60% of the respondents. As regards experience in the construction idnsutry, 71.62% of respondents had experience under 1 year, 20.27% possess between 1–5 years of experience, while 4.10% possess between 6–10 years of experience, and the proportion of respondents with more than 20 years of experience is also 4.10%. Other information on the respondents are presented in Table 1.

Table 1. Respondents background information.

Highest educational qualification	%
Others	29.70%
Master's Degree	5.40%
Bachelors Degree	41.90%
Diploma	23.00%
Profession	%
Quantity surveyor	20.30%
Other	67.60%
Mechanical Engineer	1.40%
Electrical Engineer	4.10%
Construction Manager	2.70%
Construction H & S Officer	2.70%
Architect	1.40%
Years of experience	%
Under 1 year	71.60%
More than 20 years	4.10%
6–10 years	4.10%
1–5 years	20.30%
Institution	%
Other	63.50%
Government	9.50%
Contractor	13.50%
Consultant	10.80%
Client	2.70%

COVID MOTIVATED ADOPTED EMERGING TECHNOLOGIES

The results in Table 1 present the MIS and SD of the variables for this study. It should be noted that all the variables are significant, with values above 3.00. The highest ranked is Internet of things (MS = 3.93, SD = 1.090), followed by Building information modelling (MS = 3.88, SD = 1.046), Cloud-based systems (MS = 3.86, SD = 1.051), Data Collection Apps (MS = 3.80, SD = 1.158), Artificial intelligence (MS = 3.77, SD = 1.165), Building management systems (MS = 3.74, SD = 1.159), Big Data (MS = 3.73, SD = 1.126), Radio-frequency identification (MS = 3.73, SD = 1.089), Virtual reality systems(MS = 3.72, SD = 1.129), Smart building (MS = 3.69, SD = 1.109), Machine learning (MS = 3.69, SD = 1.204), Laser scanner (MS = 3.64, SD = 1.142), Unmanned aerial vehicles (MS = 3.62, SD = 1.069), 3D printing (MS = 3.62, SD = 1.167), and lack of labor force (MS = 3.01, SD = 1.266) ranking least. Modular construction (MS = 3.59, SD = 1.097), Prefabrication (MS = 3.59, SD = 1.059), Site positioning systems (MS = 3.58, SD = 1.073), Cyber-physical systems (MS = 3.58, SD = 1.194), Augmented reality (MS = 3.58, SD = 1.123), Blockchain (MS = 3.55, SD = 1.136). the results reveal that the pandemic prompted the adoption of technologies and platforms that promote less physical human interaction. It is not surprising that the adoption of IoT technology is ranked first. This enables the connection of physical objects through embedded sensors for data exchange over the internet. The results also revealed that the pandemic prompted BIM diffusion more. This is because collaborative working was necessary virtually, and BIM provides this platform.

Table 2. Adopted technologies.

Emerging technologies	Mean	Std. Deviation
Internet of things	3.93	1.090
Building information modelling	3.88	1.046
Cloud-based systems	3.86	1.051
Drones	3.85	1.016
Data Collection Apps	3.80	1.158
Artificial intelligence	3.77	1.165
Building management systems	3.74	1.159
Big Data	3.73	1.126
Radio-frequency identification	3.73	1.089
Virtual Reality systems	3.72	1.129
Smart building	3.69	1.109
Machine learning	3.69	1.204
Laser scanner	3.64	1.142
Unmanned aerial vehicles	3.62	1.069
3D printing	3.62	1.167
Modular construction	3.59	1.097
Prefabrication	3.59	1.059
Site positioning systems	3.58	1.073
Cyber-physical systems	3.58	1.194
Augmented reality	3.58	1.123
Blockchain technology	3.55	1.136

Table 2 presents the factor analysis of the collected data. A Kaiser-Meyer-Olkin Measure of Sampling Adequacy test achieved a value of 0.902, revealing that the data is considered adequate for factor analysis. The factor analysis shows two clusters; cluster one consists of Artificial intelligence, Building information modelling, Drones, Blockchain technology, 3D printing, Virtual Reality systems, Radio-frequency identification, Internet of things, Cloud-based systems, Augmented reality, Cyber-physical systems, Unmanned aerial vehicles, Modular construction and Prefabrication. Meanwhile, the second cluster is made up of Laser scanner, Site positioning systems, Big Data, Machine learning, Smart building, Building management systems and Data Collection Apps. Cluster one is mostly technologies adopted at various aspects of the construction process to achieve productivity, monitoring, safety and efficiency. Hence, they are broadly termed construction technologies. Cluster two is focused more on data(collection, analysis and science). Thus, the second cluster is termed smart building technologies, as they can be adopted to automate and optimize building operations.

Table 3. Factor analysis of technologies.

	Component			
	1	2	% of Variance	Kaiser-Meyer-Olkin Measure of Sampling Adequacy.
Artificial intelligence	.399		61.183	.902
Building information modelling	.697			
Drones	.678			
Blockchain	.924			
3D printing	.937			
Virtual Reality systems	.851			
Radio-frequency identification	.899			
Internet of things	.502			
Cloud-based systems	.664			
Augmented reality	.774			
Cyber-physical systems	.666			
Unmanned aerial vehicles	.760			
Modular construction	.864			
Prefabrication	.516			
Laser scanner		.519	6.870	
Site positioning systems		.693		
Big Data		.501		
Machine learning		.807		
Smart building		.942		
Building management systems		.978		
Data Collection Apps		.777		
Extraction Method: Principal Component Analysis. Rotation Method: Oblimin with Kaiser Normalization.				
a. Rotation converged in 7 iterations.				

The result shows that the construction industry, especially in developing countries, is becoming more aware of the technology adoption trend, although it is not at par yet with the developed countries (Adekunle, Aigbavboa et al., 2021; Adekunle, Ejohwomu et al., 2021). It also shows

that continuous efforts are being made to adopt emerging technologies in the construction industry, although at different levels. It is not surprising that BIM is highly ranked; it has been a front burner in terms of diffusion efforts in the construction industry. Due to its inherent advantage of providing real-time collaboration, it is thus an important technology considering the various measures implemented during the pandemic. Several studies have been conducted in South Africa to understand and further BIM diffusion in the South African construction industry (Adekunle et al., 2022; Adekunle et al., 2024; Akintola et al., 2017; Chimhundu, 2015; Kekana et al., 2015; Odubiyi et al., 2019; Olugboyega & Windapo, 2021; Otasowie et al., 2023).

As regards the ranking of blockchain technology ranking least, it is also not surprising as many are not well aware of it yet. This is due to its status as a new technology (Akinradewo et al., 2022). It thus requires more awareness of its capabilities among professionals to achieve widespread adoption.

CONCLUSION

This study identified the emerging technologies in the construction industry and how the COVID-19 pandemic informed their adoption. Through a quantitative approach, the study identified and ranked the technologies. The findings reveal that various technologies were adopted during the pandemic in order to overcome its impacts. The study clustered the technologies into construction technologies and smart building technologies. The study reveals that the construction industry adopted diverse technologies due to the pandemic constraint of physical distancing and lockdowns.

It is, therefore, evident that the pandemic, beyond its negative impacts, is a driver of technology adoption in the construction industry in developing countries. Although at different rates, the construction industry achieved more in terms of technology adoption as there was the need to overcome the many challenges and measures implemented to overcome the pandemic. This study was conducted in South Africa and only identified the technologies and platforms adopted due to the pandemic. Other studies can conduct further studies on the level of impact of these technologies on construction productivity. Also, further studies can be conducted comparing the pre and post-pandemic status of the construction industry in terms of technology adoption.

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